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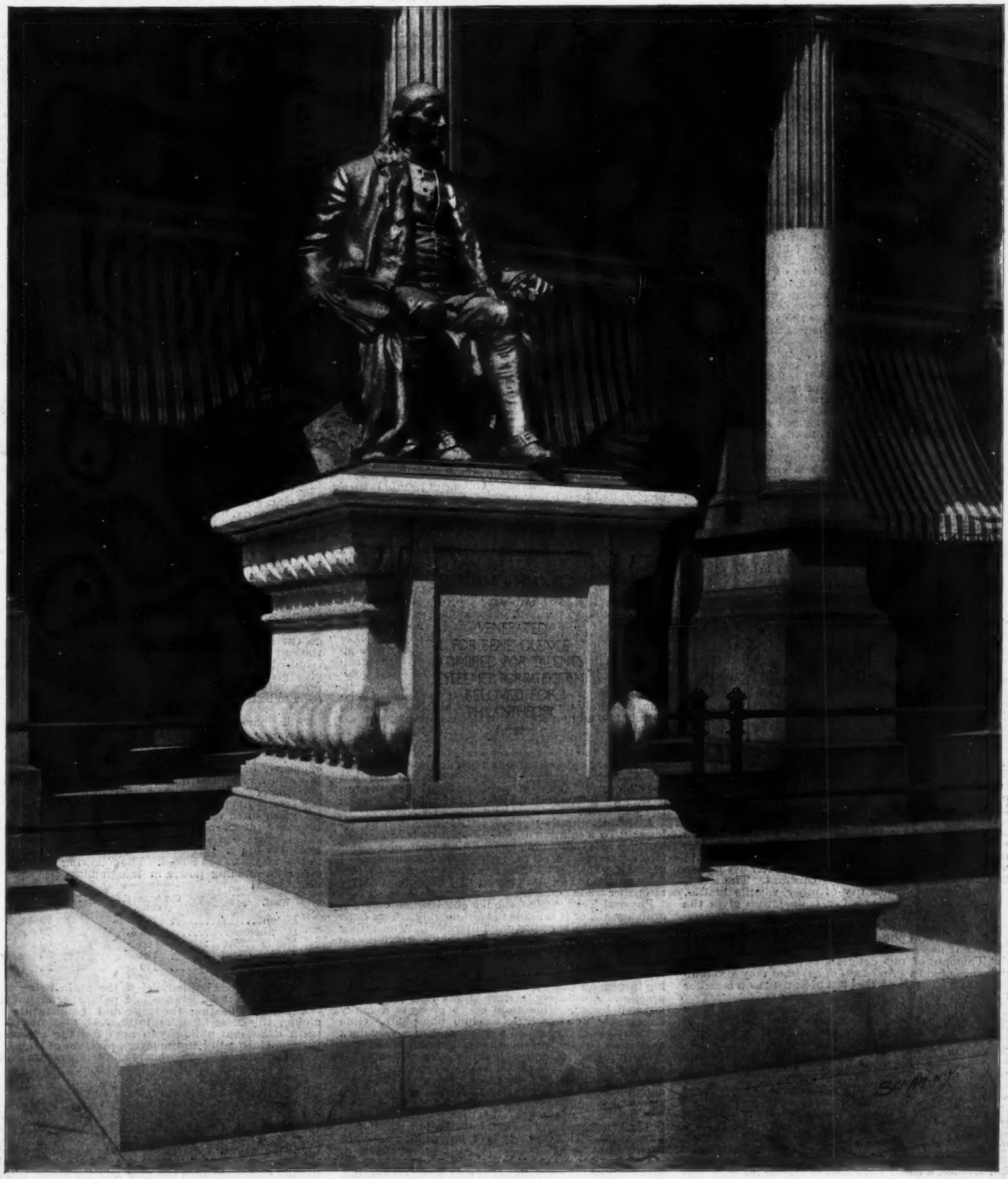


From a Photograph by W. H. Rau.

THE NEW STATUE OF BENJAMIN FRANKLIN, BY J. J. BOYLE, IN FRONT OF THE POST OFFICE, PHILADELPHIA.

THE NEW STATUE OF FRANKLIN IN PHILADELPHIA.

PHILADELPHIA was the scene of the labors of one of the greatest of Americans, Benjamin Franklin, and up to the present time the city has been remiss in providing any adequate memorial of her great son, and even his grave in a churchyard in the heart of the city seems sad and neglected. Philadelphia has always lacked an adequate monument of the great patriot, statesman, diplomat, publicist, printer, and natural philosopher. Now, however, this reproach has been removed by the erection of a splendid bronze statue, which has been placed in front of the post office building. The statue was the gift of Mr. Justus C. Strawbridge, who commissioned the Philadelphia sculptor John J. Boyle, Esq., to design and execute a large and monumental statue of Franklin. It stands on a handsome pedestal in front of the Chestnut Street side of the building. Franklin is represented as sitting in a chair, holding an open roll of papers. The pose is lifelike, and the sculptor has been aided in his efforts by the costume of Franklin's time, which enabled him to represent the great man in dignified, and at the same time picturesque, raiment.

The presentation ceremonies were conducted under the auspices of the University of Pennsylvania, the American Philosophical Society, the Franklin Institute, the Library Company of Philadelphia, the Historical Society of Pennsylvania, and the Pennsylvania Hospital. The interesting event occurred on Wednesday, June 14. The addresses were made in the Chestnut Street Opera House by United States District Attorney J. N. Beck, who has more than a local reputation as an orator. The presentation speech was made by the Postmaster-General, Charles Emory Smith, for Mr. Strawbridge, and the statue was accepted by Major Ashbridge. In presenting the statue, Postmaster-General Smith dwelt upon the distinguished services of Franklin and upon his modesty. He said: "He was the founder of the nation and a citizen of the globe. Of many-sided greatness, he was the foremost man in the nation."

Mr. Beck said: "Franklin was the incarnation of democracy, the first self-made man of America, and the greatest when the versatility of his genius is considered. He was, moreover, a typical American, combining with Abraham Lincoln more of the characteristics of our people than any great man in our history."

The location of the statue is most appropriate, standing, as it does, in front of the post office, with which branch of the government service the name of Franklin will ever be linked because he was the first head of the postal system.

From a scientific point of view, Franklin's researches in electricity are the most important, and the many-sided Philadelphian first brought the modern practical spirit to bear upon electrical investigation. Not being satisfied with mere brilliant experiments and speculations, his researches had for their final aim the definite determination of the phenomena of nature, and, as far as possible, their adaptation to the service of man. To him we owe the remarkable investigations which he made upon the Leyden jar, and it was for him to prove the identity of lightning and electricity and to propose the theory of the lightning rod and to put it into practice. For this and for his other discoveries the name of Franklin is assured of a commanding place in the history of science of all times and all countries.

GLUE TESTING.

By S. RIDEAL, D.Sc. Lond., F.I.C.

CHEMICAL EXAMINATION.

THE determination of water and ash is necessary in order to render the other results comparable, and to assist in detecting adulteration. Ordinary glue of good quality contains from 12 to 18 per cent. of water; a low result is generally a bad sign, as over-drying is known to injure the tenacity, while a high percentage diminishes the keeping qualities, besides adding spuriously to the weight. The ash is usually from 1·5 to 3 per cent., and its amount does not discriminate between hide and bone glues. It will obviously be much higher if mineral fillings have been added or the source is impure. The qualitative examination of the ash, on the other hand, gives a clew to the origin, as the ash of bone glue fuses, its solution is neutral, and it contains both phosphoric acid and chlorine, whereas ash of hide glue does not fuse, because it contains lime; it is alkaline, and nearly or quite free from chloride or phosphate.

After breaking in small pieces, a sufficient quantity of the glue is either reduced to shavings in a machine, or is pounded in a mortar, the pestle passing through a perforated carboard guard to prevent scattering. One or two grammes of the coarse powder weighed in a platinum dish are dried first in the water oven, then at 110-115° C., till the weight is constant. The loss is water plus a small quantity of other volatile matter. Cautious incineration at a low temperature gives the ash, which should dissolve almost completely on warming with dilute nitric acid, the solution being tested for chlorides and phosphates, and also for other substances if necessary. The presence of more than a small amount of salt deteriorates the quality and appearance of glue. An excess of chlorine may also indicate that chloride of lime has been used as a bleacher in the manufacture.

In a number of patents various earthy powders are added to glue during manufacture with the object of increasing its adhesive properties. This is regularly the case with Russian glue. White lead, lead sulphate, zinc oxide, barium sulphate, and even lead chromate have been used. These substances would be found in the ash.

Reaction of the Glue.—If acid, about 10 grammes of the powder are dissolved in warm water and divided into two portions; in one the total acidity is estimated by standard alkali, the other is evaporated on the water bath, redissolved, and the fixed acidity determined. The difference gives the volatile acids. As the nature and amount of the acids present in glue is often of importance, a closer examination may be made by distilling 30 grammes in 100 cubic centimeters of water by a current of steam, when the volatile acids will pass over. The distillate should be examined for free sulphurous acid, as it is sometimes present, having been used for preserving or bleaching, and its presence is generally objectionable. In leather glues the volatile acids are about 0·02 per cent., in bone glues from 0 to 0·5, the higher amounts, with a smell of acetic or butyric acid, indicating that the jelly has been soured during the manufacture and that the glue is unsuitable for many purposes. Kissling states that glue solutions which do not alter litmus may yet react with phenolphthalein, "probably owing to an organic acid." He estimated this with soda, but did not ascertain its nature.

Any undue quantity of acid can be roughly detected by the taste. Glues may be alkaline from the addition of excess of lime in the manufacture to correct the sourness of the jelly. A large manufacturer informs us that "a little acid or a little lime does not hurt, though it is much better neutral. We find that our customers prefer a glue that shows a little lime, rather than any acid, although an acid-made glue is not nearly so apt to decompose as a lime-made glue." It must be remembered that the bacteria which cause the changes are antagonized by acids. For uses where colors are concerned the glue must be neutral to litmus; for adhesive uses this does not matter, unless it is due to defective preparation. When the solution of glue in hot water rises higher than 100° C., it begins to sour, and loses to some extent its property of forming a jelly. Sulphurous acid and sulphites are said to cause light patches on dyed wool. Kalmann states that the amount of sulphite can be determined in the remains of the acidity titration with soda and phenolphthalein, by means of iodine solution and starch, the organic matter not interfering. He mentions that for woolen manufacturers the glue must not exceed free acid equal to 1 per cent. Na_2O, SO_2 0·5, ash 3, water 15 per cent.

Insoluble Matters.—As extraction with water, filtration, and weighing is somewhat tedious, a comparative result may be obtained by dissolving 30 grammes, making up to one liter in a graduated cylinder with hot water, allowing to stand in a warm place for twelve hours, then noting the volume of deposit as "foreign matter," stating the quantities taken. The solution may be used for other tests.

Determination of Gelatine.—The organic matters of glue are very complex. Among the nitrogenous matters to be found in it there are probably several varieties of gelatine and chondrine, as analyses of these substances, presumably pure, show differences in elementary composition, in addition to the variations in physical properties. Products of change, such as albumoses and peptones, are usually present with small quantities of bases, sugars, and ill-defined bodies. For this reason the content of nitrogen and the various processes of precipitation by tannin, etc., yield results which have little relation to the commercial value. Gelatine has a greater power of adhesion and gelatinization than chondrine; the latter, however, is largely employed for size.

The Bisler-Beumat method of tannin tritration is briefly as follows:

Two solutions are prepared: (a) 10 grammes of pure tannin to the liter; (b) 10 grammes of pure isinglass and 20 grammes of alum to the liter. The latter is added to a measured quantity of the former till no further precipitate is produced; the volume used is read off on the burette. The same volume of tannin is then precipitated by a 1 per cent. solution of the glue; the relation between the volumes of glue solution and of isinglass gives the ratio of the glue to the sample of isinglass taken as a standard.

Different specimens of isinglass and of tannin themselves show different ratios of precipitation; 42·7 parts of gelatine are said to be equivalent to 57·3 of tannin, but the precipitate is somewhat variable in solubility and composition. Another process is to add tannin in excess, and estimate the amount left in solution by running in standard permanganate as long as decolorized. Stelling precipitates by tannin and evaporates, and weighs the "matters not glue." This is by no means accurate. The proteids can be more exactly precipitated by chlorine (Rideal & Stewart, Analyst, September, 1897), or by bromine (Allen & Searle, ibid., October, 1897).

The presence of chondrine reduces the value of gelatine, especially for photographic emulsions. It may be detected by adding a concentrated solution of chrome alum to the glue or gelatine, dissolved in ten parts of boiling water; if any injurious quantity of chondrine be present, the liquid will set while hot.

Fat is very objectionable in glue, and for many purposes must be entirely absent. It renders the hot solution turbid, and on standing collects at the top as a greasy film, which may be removed by ether when the jelly cools.

A manufacturer's "grease test" is described as follows: "To a solution of glue add a little lampblack or Turkish red; thoroughly mix with a brush, and paint it on some pieces of paper; if there is abundance of grease it will show by little round, white, smooth surfaces on the red or black paint. Specially required for the paper trade and some others."

Physical Tests.—Glue should not become damp in ordinary air, or it is liable to turn mouldy. This fault would indicate impurity or adulteration. The author has met with a few instances of weighting with coarse sugar, molasses, or dextrine, in which this peculiarity was conspicuous.

1. The appearance, hardness, and manner of breaking furnish an idea of value which can be learnt by practice. A splintery fracture shows that the glue is not well boiled. Glue from bones presents a milky appearance, due to a little calcium phosphate. Glue without gloss, very much warped, and of a very dark color, may be excellent in adhesiveness and tenacity.

2. Drying and Keeping Qualities.—About ten cubic centimeters of a 20 per cent. solution are placed on a watch glass in a cool, dry place, protected from dust, and observed for several days in comparison with a standard sample.

3. Smell.—Varies much. Leather glue smells least. Some do not smell when cold, but the hot solution is unpleasant. This property is of importance for some uses.

4. Behavior with Cold Water.—Schattenmann in 1845 proposed the absorption of cold water on soaking. Ten grammes of the sample in small pieces are placed in a weighed beaker, and covered with 200 c. c. of water, and kept covered at 60° F. for forty-eight hours. The water is then poured off and the remainder weighed. According to my experience, good glues will absorb about five and a half to six times their weight of cold water, and still exhibit a firm jelly. Some will even absorb eight to ten times their weight and still remain fairly firm. The more consistent and elastic in this state the greater the adhesive power, and the more water it absorbs the more economical in use. Bad glues will often become slimy and fluid in less than forty-eight hours. The water poured off should be free from putrid odor, and contain little in solution. The test is specially applicable to bone glue; that from animal offal does not show the same behavior.

Kissling soaks 100 grammes of the glue (apparently unbroken), supported on fine wire gauze, in cold water, and weighs at intervals of twenty-four hours, draining fifteen minutes before each weighing. In forty-eight hours he obtains numbers from 221 grammes to 332 grammes of water absorbed, his highest figure being 723 grammes in 216 hours. This method seems inferior to the above. Still less can Cadet's method, absorption in damp air, be recommended.

5. Lipowitz's Method, 1861: Consistency and Bearing Weight of the Jelly.—A 10 per cent. hot solution (the jelly from the 10 grammes in the preceding process, No. 4, could be made up to 100 grammes with hot water) is allowed to stand twelve hours at 18° C. in a cylinder of uniform width to gelatinize. A metal rod is soldered to the center of the interior of a small tin cup, and is supported vertically by passing loosely through holes in two horizontal plates, one of which forms the cover of the cylinder, the other being fixed a little higher. The upper end of the rod carries a funnel, which can be loaded with fine shot. The cup is allowed to rest on the jelly, and the funnel is loaded until it sinks a certain distance into the jelly; the weight of shot then gives the Lipowitz number. The cylinder should be surrounded by a water-jacket to maintain a definite temperature. The result is also affected by the diameter of the cylinder and of the cup. Lipowitz gives the following figures:

Variety of Glue.	Weight required to force the Saucer down. Pounds.
Breslau	3·74
Russian	3·18
Cologne	2·67
Muhlhausen I	1·60
Nördlingen	1·59
Muhlhausen II	0·85

The table from which the above figures are taken also contains the following: 1. Water 9 to 21. 2. The percentage of gelatine by tannin is in the same proportion as the water absorbed. 3. The weight supported by the jelly corresponds neither with the absorption nor content of gelatine, nor with the price.

A commercial form of the above, called the "shot-test," is made by cooling the 10 per cent. solution in an ice-box for three or four hours till firmly set. A tube or small beaker is placed on the jelly and loaded with shot till it sinks. By this method I have found that a 10 per cent. jelly will bear a weight, ranging in different glues, from 64 to 12 grammes, and in bad cases falling to 0, the glue being liquid. Kissling ascertains how many seconds are taken by a glass, a zinc, and a brass rod to sink to a zero mark into a jelly. He finds that skin glues have a higher consistency of jelly, less odor, impurity, and volatile acid than bone glue, the water, ash, breaking strain, and absorption of water being about the same in both classes. But, like other observers, he can find no definite or constant relation between these factors and the price.

6. Weidenbusch, 1859: Breaking Strain of a Rod made of Glue and Plaster of Paris.—Sticks of plaster cast of uniform size, saturated with glue and dried thoroughly, are placed one by one in a metallic ring having notches to receive them, and a lever with the center of the stick as the resistance, and a mercury cup on the long arm as a weight. Mercury is poured into the cup till the stick commences to break. The weight required is recorded, and compared with a standard glue gives the "Weidenbusch figure." For special purposes where glue is required as a body this would seem to be a practical method, but it is somewhat uncertain.

7. Karmarsch proposed, and the Artillerie Werkstätte, Spandau, has adopted, the severing strain of two blocks glued together. For the important objects of joinery and cabinet making this would seem to be an eminently natural process, all the rest being more or less arbitrary and artificial, except with reference to covering power and economy. But by a large number of experiments it was found that the error in duplicates was often very large, as has also been remarked by other observers. Hence, I undertook an investigation of the causes of inaccuracy. These were found to consist of: 1. Inconstancy of material and surface in the blocks to be severed. The following figures are given for holding power in kilogrammes per square centimeter:

Wood.	Cut Across the Grain.	Parallel to the Grain.
Beech	155	79
Hornbeam	126·5	79
Maple	88	63
Oak	128	55
Fir	110	24

The hold on wood cut parallel to the grain being the same whether the fibers are laid parallel or crosswise.

2. Time of heating the glue and temperature of gluing, thickness of glue interposed, pressure used (with occasional obliquity in applying the pressure, therefore inequality in the layer), presence of lumps.

3. Moisture in the atmosphere and temperature while setting, and duration of rest before trial.

4. Temperature, etc., while testing.

5. Possible jerking in applying the weight.

Kissling substituted for wood two vertical solid cylinders of nickel plated iron, with one end smooth and the other with a hook for applying the strain. But there is a great practical objection to using an absolutely non-porous material for the surfaces to be glued. On examining the fracture it will be found that it usually occurs between the glue and the metal, therefore the measurement is simply that of the adhesion of the glue to the metal; whereas, in practice, if a joint properly made be examined after rupture, it will be found that the parting takes place through the

substance of the glue layer itself, about half of which remains attached to each face of the wood, so that the test is a practical measure of the cohesion of the glue. Roughening, lining, or grooving of the metallic surface does not remove this objection.

On the other hand, in severing glued wood it frequently happens that the fracture breaks into the substance of the wood itself, the latter having a lower tenacity than the glue; here the test is obviously valueless.

Bauschinger devised a sliding or lateral test, in which two pieces of red beech wood, a decimeter square, were glued together with their fibers parallel and their surfaces overlaping one centimeter. The pieces were fixed in a Werder's testing machine and forced in a direction parallel to their surfaces till the glue yielded and the pieces slid over one another. This test is only advisable for special uses, as friction interferes and the wood itself frequently breaks; moreover, in joinery a slide is usually stopped by a mortise.

Horn determined the resistance to a tearing force of the substance itself, as: Common glue, 9·6 kilos. per square centimeter; Cologne, 10·6; gelatine, 31·5.

By a large number of experiments I was led to adopt the following process and precautions:

For the testing blocks a hard yet moderately porous biscuit stoneware was found to be a much better material than wood. They were made to our design by Messrs. Doulton, and were of the shape of a truncated wedge fitting the claws of the machine—a glue-tester by Bailey of Salford, with a system of levers, and a weight tub loaded with shot which was afterward weighed. The opposing planes showed a fine uniform grain; they were accurately ground to the square inch. After using they were boiled clean and dried for further use.

One part of broken glue soaked in two parts of cold water for six hours, then raised to 70° C., agitated in a covered vessel till dissolved, and rapidly strained through fine muslin. The plane surfaces were soaked in this for thirty minutes at 70° in a covered vessel joined carefully with light pressure, the pairs mounted in a frame between uprights, each pair being cautiously loaded with a weight of 5 lb., and the whole kept for five days in a cool and dry room. At the end of that time they were mounted in the machine and tested, the utmost care being taken to avoid jerking, to put on the weight gradually, and to keep the lever horizontal. An improvement on shot would be a hopper with dry sand or mercury flowing through a regulated orifice with an automatic cut-off at the moment of fracture, which is generally sudden. Supports must be placed just underneath the weight tub.

Example.—A brown Scotch glue of excellent character gave with four different pairs of stone blocks a breaking strain of 675 pounds, 636 pounds, 712 pounds, and 645 pounds per square inch. The average of all the mahogany blocks (ten experiments) was 331 pounds, but the single experiments varied from 70 pounds to 668 pounds, showing scarcely any regularity or certainty. The stone, on account of its lower porosity, worked best with 50 per cent. glue, the mahogany with 20 per cent.; a thin film of glue remained attached to both stone surfaces after rupture. The greatest advantage that stone blocks possess is their rigidity, the largest source of error in wood blocks being due to the elasticity and compressibility of the wood, and consequent yielding and slipping during the test, which often brings about the fracture prematurely, and occasions abnormally low results.

A rough method of glue testing without apparatus is to cut transversely with a fine saw a stick of wood 5 centimeters (1 inch) square, to glue the cut surfaces together and mount them on end with a moderate weight on top. After three days the bar is laid across the supports, and weighted gradually in the middle till fracture ensues. Good glues should sustain a weight of at least 75 kilogrammes.

8. Viscosity or "Body" Test.—An American manufacturer sends me the annexed description of this process as practiced by their firm:

"One ounce of glue is soaked thoroughly in 10 ounces of water, melted in the water bath, poured into a 'testing tube' kept at a standard temperature, and the time observed that is taken in running through. 'Water requires 37 seconds, while the very weakest glue takes 40 to 43 seconds.' The ratio is the 'body test,' indicating the consistency of the glue and the amount of surface it will cover, and, therefore, its cheapness in use and good working and water-taking qualities. We attach more importance to this test than to the consistency of the jelly." The above determination would show a ratio in 10 per cent. solution, taking water as a standard, of $\frac{37}{43}$ for the very weakest glue, or in decimals 1·16.

Julius Fels employs Engler's viscosimeter (improved form, Journ. Soc. Chem. Industry, 1890, p. 654) with a 15 per cent. solution, and subjoins this table:

Number.	Description of samples.	Per cent. of moisture in original.	Time of efflux of 500 c.c. at 30° C. in seconds, water taking 90 seconds.	Viscosity.
1	Light yellow transparent thick plates	16·3	149	1·65
2	Brown transparent glue	14·0	125	1·36
3	Sherry colored transparent glue	15·4	171	1·91
4	Light yellow plates, brittle	18·2	150	1·60
5	Muddy (fuller) glue	15·2	199	2·21

He remarks that "the viscosities found agree with the respective behaviors under water. No. 2 became entirely slimy in a few hours and fused into one lump, whereas No. 5 kept its shape, and on scraping with the finger showed scarcely any gelatinization. Nos. 3 and 5 in twelve hours gave a thick jelly, while No. 2 in twenty-four hours yielded only a poor and thin result."

The ordinary preference for a dark glue is justified by the above figures. No. 2 seems to have been overdried. Lighter glues may have been bleached at the sacrifice of tenacity.

In determinations of viscosity I use and prefer an apparatus modified from Slotte's form, which I have described and figured in the Journal of the Society of Chemical Industry, 1891, p. 615, as being simpler, cheaper, more manageable, and giving the datum in terms of absolute measurement. The numbers given by different observers have been obtained at different temperatures and with different strengths, hence are not strictly comparable. Thus, Fels worked at 30° C. with a 15 per cent. solution, the Americans with 10 per cent. "at a standard temperature." Therefore conditions should also be stated. I have been accustomed to use a 1 per cent. solution at 18° C., operating in the way mentioned in the above paper. It is essential to pass the solution first through a capillary tube by pressure to remove lumps, which are more frequent in "muddy" glues; some of the high figures found for this class (e. g., the 2·21 in Fels' table) may be due to this feature. Straining through muslin is not sufficient, but should be used as a preliminary. My figures for different varieties (1 per cent. at 18° C.) have ranged from 1·19 to 1·6.

Kissling has recently given the following table of tests for different glues (Chem. Zeitung, xxii., [19], 172):

Number.	Description.	Price per cwt. in shillings.	Smell of soaked glue.	Consistency of jelly (rod method).	Viscosity of 17 per cent. solution at 25° C.	Non-gelatine percentage (Skelling).
1	Skin glue	44/–	good	over 1,000	15	7·6
2	"	44/–	"	....	9	8·2
3	"	48/–	very good	130	4	8·3
4	Bone glue in powder	36/–	fair	5	4·2	14·8
5	" "	30/–	unpleasant	140	5·5	....
6	" "	36/–	fair	1	3·7	....
7	" "	36/–	"	234	7·4	15·0
8	Mixed glue	41/–	bad	1·5	2·8	13·6
9	Bone glue in cakes	28/–	"	2·4	....	15·4
10	" "	26/–	very bad	....	....	23·2
11	" "	26/–	rather bad	liquid	2·8	15·6
12	" "	26/–	bad	120	4·4	8·75

The author remarks that the fluidity alters considerably on standing. "The smell is especially important, as indicative of the keeping properties. (Compare No. 3 and No. 12 above.) In adhesive power, cheap bone glues give almost as good results as the high priced skin glues. If a glue buyer requires good smell, gelatinizing property, and freedom from acidity, a best skin glue must be selected. If only the adhesive properties are to be considered, a cheap bone glue will answer the purpose."

9. Foam Test.—A 10 per cent. solution is beaten or stirred vigorously for three or four seconds with a small glass rod, the height of the foam measured in inches, and the rate of its disappearance noted. "Some glues show ⅛ inch foam, some ¼ inch, ½ inch, and some none at all. It does not necessarily follow that there is anything wrong with the glue, but a great many customers object to foam." For some purposes frothing is a great disadvantage.

VALUATION OF RAW MATERIALS.

The value of glue-making materials, more especially of tanners' "spetches" (refuse and parings), depends not only on the absolute amount of glue-forming substance, but also on its relation to the non-gelatine. Gantter boils 100 grammes of the sample with 1 liter of water and a few drops of soda till completely extracted, makes up to 2 liters and allows to stand covered in a warm place for ten hours. The insoluble matters settle, while the fat rises to the surface. The residue and ash are determined in 20 cubic centimeters (= 1 gramme of substance). Another 20 cubic centimeters are diluted, neutralized with acetic acid, precipitated by tannin, filtered, and any excess of tannin withdrawn by hide-powder; the liquid evaporated, dried, and its ash deducted, gives the organic non-glue-making material.

It may be said in conclusion that a careful inspection of the results of the scientific examinations of a glue or of raw materials gives frequently a better criterion of its value for a definite purpose than the price, as the latter is often determined by hand tests and by artificial considerations.—The Builder.

PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.*

I THINK I may fairly assume that every one in this theater has had their photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted-on plate in a solution of say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results, so strongly resembling those produced by light, are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals—magnesium, cadmium, zinc, nickel, aluminum, lead, bismuth, tin, cobalt, antimony—are all capable of acting on a photographic plate. Magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favorable conditions a picture may be produced in two or three seconds.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is entirely without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. This first slide is the picture given by a piece of ordinary zinc which has been rubbed with some coarse sand-paper, and you see the picture of every scratch. Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55° C. In the other cases, which are on a larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate much action has occurred. In the other case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55° C., then half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture, as is shown by the following pictures, which were taken respectively at a distance of 1 mm. and 3 mm. from the scratched zinc surface. The appearance of the surfaces of different metals varies, and the following slides show the surface of a plate of bismuth, a plate of lead, and one of aluminum. On the next slide are the pictures produced by similar pieces of pure nickel and cobalt, and it clearly shows how much more active in this way nickel is than cobalt. Many alloys, such as pewter, fusible metal, brass, etc., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with 30 per cent. of zinc produces hardly any action on the photographic plate, but when 50 per cent. of zinc is present there is a fairly dark picture, and when as much as 70 per cent. is present, a still darker picture is produced.

The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time might arise from vapor given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids it is convenient to use small shallow circular glass vessels such as are made for bacteriological experiments, the plate resting on the top of the vessel, and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the terpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong-smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemons, etc., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore ordinary scents are active bodies, and this is shown by the following pictures produced by eau de Cologne, by cinnamon, by coffee and by tea. Certain wines also act in the same way. Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies; linseed oil is especially so; olive oil is active, but not nearly as much so as linseed oil; and mineral oils, such as paraffin oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture, as is shown by the following slides; the first is a section of a young spruce tree, the next a piece of ordinary deal, and the third of an old piece of mahogany. Again, the next slide you will recognize as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colors from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. In the picture before you the ink was at a distance of one inch from the plate, and the next slide shows what a remarkably clear and dark picture ordinary printing ink can give. As the composition of printing ink varies so does its activity, and here are pieces of three different newspapers which have acted under the same conditions on the same plate, and you see how different the pictures are in intensity. Printed pictures, of course, act in the same way; here is a likeness of Sir H. Tate taken from "The Year's Art." The pictures and printing in Punch always print well, so does the yellow ticket for the Friday evening lectures at the Royal Institution; also the rude trade-mark on Wills' tobacco, and it is of interest because the red pigment produces a very clear picture, but the blue printing is without action on the plate.

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sand paper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its color is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary

* A lecture delivered at the Royal Institution on Friday, May 5, by Dr. W. J. Russell, V.P.R.S.

temperatures. Gold beater's skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance, paraffin does not, and among common substances writing ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter written in 1801 shows; also this letter of Dr. Priestley's, dated 1795, and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water mark of certain old and modern writing papers. Some modern writing papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of the strong activity of the printing ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was "dark light," which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapor given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well known chemical compound, hydrogen peroxide, which, undergoing decomposition, acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present, peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was not evident what common property bound them together.

Now, however, the explanation has come, for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body, peroxide of hydrogen. Schönbein showed as long ago as 1860 that when zinc turnings were shaken up in a bottle, with a little water, hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can, in the presence of moisture, produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance, producing a picture like that produced by zinc, and that the action was traced to the turpentine present; again, a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now, a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerable quantity and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture. It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of Paris, wet it with the peroxide solution, and let it set "in a mould," so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, etc.; see, for instance, this one of a 5-pound note and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as theirs does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained, I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright, active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed; but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one. Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours, the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now, if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a high temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus, place a stencil on a piece of bright zinc, and expose the plate to the action of an active plaster of Paris slab, or to active blotting paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil. Any inactive body—for instance, a piece of Bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of Bristol board, and a slab of active plaster of Paris be placed on the stencil for a short time, the Bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a colored advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was ultimately traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

I would only add that this investigation has been carried on in the Davy-Faraday laboratory of this institution.

LATHE MILLING ATTACHMENT.

WE illustrate on this page a lathe milling attachment which should prove an extremely handy tool in small jobbing shops, and other places where there is not sufficient work to keep a regular milling tool going. The device, says Engineering, which is exceedingly simple, consists of a saddle moving on a vertical slide, and carrying a journal in which either a blank holder or a milling arbor can be placed. A single bolt suffices to secure the device to the top plate of any slide rest. As shown in Fig. 1, the device is arranged for the milling of a group of five mild-steel ratchet wheels. These wheels had each twenty teeth; the diameter was 3 inches, and the thickness ¼ inch each. The index wheel at the back of the device insured the accurate spacing of the teeth. The cutter was carried on an arbor, supported on the lathe centers, and driven by a dog from the face-plate. The whole group was finished in one hour. For such jobs as the milling of long keyways the work to be operated on is fixed between the lathe centers, and the cutter mounted on an arbor carried by the attachment in question. The cutter is then turned by hand, the long handle shown giving ample power for quite heavy cuts, and the feed is obtained from the leading screw of the lathe. In this case the work operated on is prevented from turning by a small bracket clamping it to the lathe bed. When the workman needs a rest, he has simply to throw the leading screw nut out of gear. The makers state that two keyways, each 20 inches long by ¼ inch broad by ⅜ inch deep, were milled in a screw for a steam rock drill with the device in about two hours. For grooving taps the device is also exceedingly handy, and with it we have seen a 1-inch tap of tool steel milled with three grooves, the cutter changed and the tap squared at the end in the space of about half an hour. The grooves, we should add, were cut the full depth at one pass of the cutter, as were the faces of the squared end. The device has the great advantage of not needing an overhead gear for operating it, and is put in place and removed from the lathe as easily as an ordinary turning tool. The makers are Messrs. J. Smart & Co., of North End, Erith, Kent.

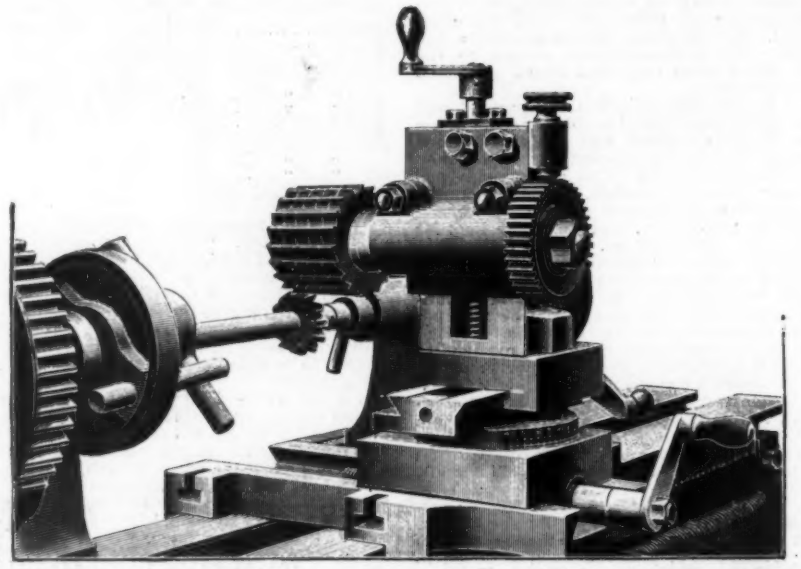


FIG. 1.

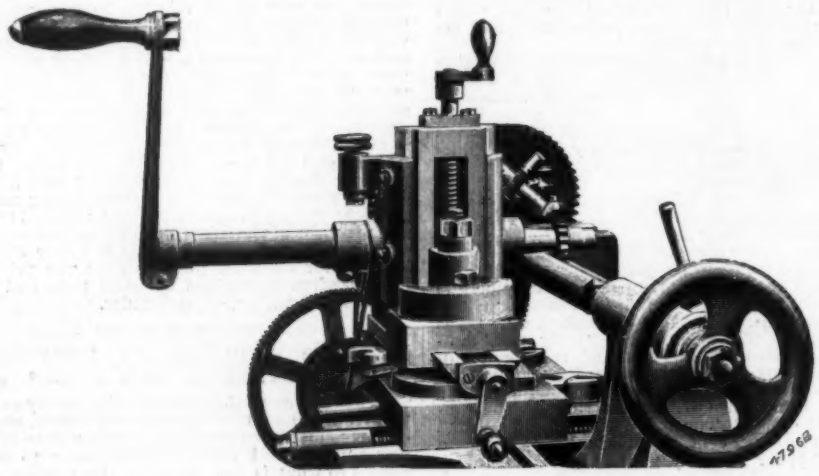


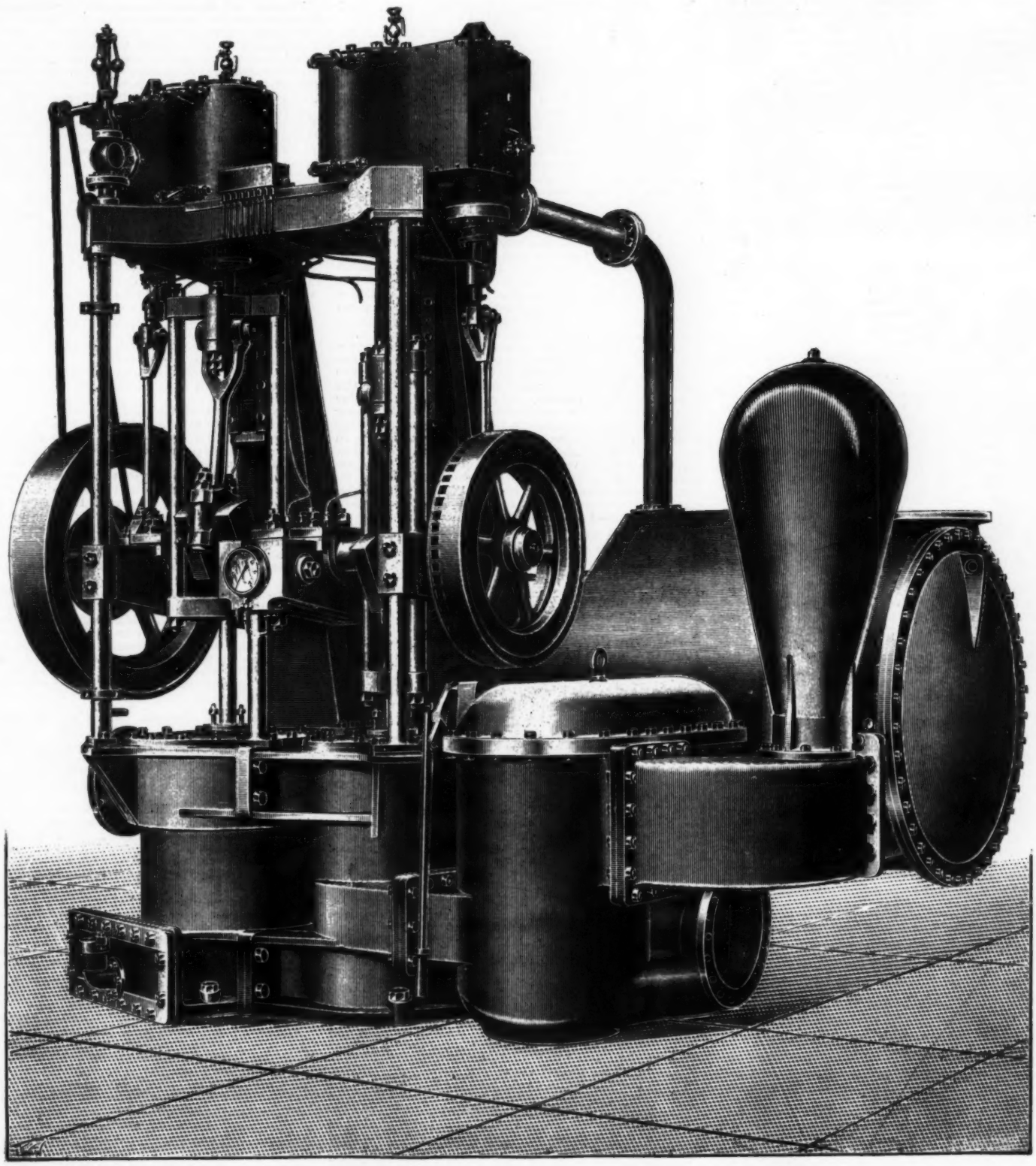
FIG. 2.

LATHE MILLING ATTACHMENT.

At Lowestoft, England, a low iron lighthouse has been moved 250 feet inland. It was built in 1866, and weighed 130 tons. It was carried on roller carriages which traveled on steel rails fixed to wooden sleepers, and the lighthouse was moved by hydraulic jacks.

LARGE CONDENSING PLANT.

WE illustrate herewith, says The Engineer, a self-contained surface condensing plant, which we believe is the largest of its kind constructed in this kingdom. It was built by Messrs. W. H. Allen, Son & Company, of Bedford. The condenser has a tube surface of 2,000 square feet, and is capable of condensing continuously 24,000 pounds of steam per hour with a vacuum varying from 27 inches to 28 inches, according to the barometrical changes. The shell of the condenser is of cast iron, cylindrical in form, fitted with tube plates of rolled naval brass and tubes of solid drawn brass, the latter being fixed into the plates by means of screwed ferrules and tape packing. The ferrules are made with lips to prevent the tubes slipping out of place. The gun-metal, with large area and small lift, so as to prevent any shock due to the water. When condensing 24,000 pounds of steam per hour, the speed of the engine is sixty revolutions per minute. The weight of the whole plant is 390 hundredweight. It has been specially designed for electric light stations.



COMPOUND CONDENSING PLANT.

condensing water passes into the condenser at the bottom and out through the top.

The engine driving the air and circulating pumps is of the inverted compound form, having cylinders 10 inches and 17 inches diameter, by 14 inches stroke. Two flywheels are fitted to the crankshaft to enable the plant to work slowly. The air pump contains suction valves, bucket valves, and head valves and is single-acting. Its diameter is 25 inches and the stroke 15 inches. The valves, and seatings, and barrel are of gun metal, and the clearance space between the valves has been reduced to a minimum in order to obtain the highest possible vacuum. The circulating pump is double-acting, having a diameter of 19 inches and stroke of 14 inches. The valve box is a separate casting. The inlet and outlet valves are of

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The Undermining of London.—The peril that threatens London, and that is about to lead to statutory action in Parliament, is serious. But it is one by which Paris, Rome, and a number of other great cities of the Old World are menaced in the same way. One hundred years ago, there was practically no underground London, save along the river's edge, where wine-cellars centuries old extended for several miles. To-day there is almost as much life and traffic beneath the surface of the British metropolis as above it. Two and even three tiers of underground railroads, with their underground stations and shops, as well as other large conduits, tunnels, sewers, and subways of every description, honeycomb the subsoil of London to the depth of more than 100 feet, and unless some check is offered to this form of enterprise, there is no knowing where it will end. The results of this tampering with the foundations of London are beginning to be felt, and are giving rise to no end of alarm. A goodly portion of the metropolis appears threatened with subsidence, and the gravest fears are entertained for Westminster Abbey, St Paul's Cathedral and other historic state edifices. In fact, no one would be surprised to learn that their safety has become affected by the imprudent interference with their foundations. It was only the other day that the London papers placed on record an alarming subsidence in Hyde Park, where the ground suddenly showed a rift several hundred feet in length, and a week later the sinking of about a hundred yards of the roadway on one side of Fleet Street, while the police reports and the weekly returns of the building inspectors are said to furnish sensational reading with regard to the large number of big edifices in the City, and mansions, both great and small, in the residential districts, that show cracked walls, that are tottering, or that are actually wrecked by the subsidence of the ground. A curious feature about the whole affair is that, in spite of all these burrowings, no one seems to possess any definite knowledge as to their extent, and it would appear that they are, so to speak, uncharted. For it was only ten years ago that general amazement was caused by the chance discovery that a gigantic metropolitan sewer passed right under Buckingham Palace, and that it was so imperfectly constructed as to have impregnated the entire subsoil of this, the Queen's London residence, with sewage, a circumstance which served to account for the fact that Her Majesty invariably complained of feeling ill after spending more than twenty-four hours in this palace. That a huge sewer of this kind should have existed right under the palace within a few feet of the floors of the royal cellars without any one being aware of its presence there speaks volumes for the happy-go-lucky methods that govern the subterranean portion of the British metropolis.—Ex-Attaché in the N. Y. Evening Post.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Notes and Suggestions for Trade with Scotland—Auto-Cars.—The motor car has become a familiar object in the streets of Scottish cities, and it is often seen also on the country roads. This vehicle was introduced in Edinburgh by a local auto-car hiring company early in 1898. During the spring and summer of last year, a car with a seating capacity of eight was run regularly between the post office and the Forth Bridge, a distance of about 9 miles. This method of transit gradually won public favor. As the traffic increased, other cars were added. The company, finding the Forth Bridge experiment a success, decided to run motor cars on certain routes in the city. Since these routes were established, the public patronage has increased steadily, and the returns of the company during the current year have been quite satisfactory. The rate of fare is practically the same as the rate on the corporation tramways, averaging 1 d. (2 cents) per mile. This is about the rate also, I am informed, says United States Consul Rufus Fleming, of Edinburgh, in Glasgow, Dundee, Aberdeen, Hamilton, Falkirk, and other cities where auto-car companies are operating. That the motor cars have a promising future in Scotland, there seems little room for doubt. They can be run into the rural districts in every direction, both for passenger and goods traffic. There are almost as few country roads as city streets on which these vehicles can not safely and easily go. An indication of the widespread and growing interest in the motor car throughout Scotland is found in the increasing attention given to the subject by the press. The expansion of the motor-making industry, the changes and improvements in the vehicles, and the development of the street transit motor lines are now matters of frequent comment.

It is announced that the directors of the Glasgow exposition of 1901 are making extensive provision for an exhibit of these vehicles in the locomotive and transportation department, with facilities for the practical demonstration of their merits. The auto-cars now in use in Edinburgh and district are of British manufacture. There seems no reason why an opening should not be found here for American vehicles of this class.

Boots and Shoes.—Ladies' boots and shoes of American manufacture are sold by several of the prominent shops and company stores in this city. The demand for them steadily grows, especially with the better class of customers. They have largely superseded the French boots and shoes; in a word, they are the fashion. American boots for ladies sell at about 19 s. ($4.62); shoes at about 12 s. ($2.92) a pair. The manager of a leading shop tells me that these boots and shoes are in high favor, owing to their elegant shape and appearance and to their fit. The leather of the uppers in the standard qualities is here considered wonderfully fine—the finest known, in fact—and the stitching is perfect. He finds fault, however, with the sole leather. He says that it is not always the best quality, and the best is required to keep out the dampness in the wet Scottish winters. Therefore, American boots are not in equal demand all the year round, the sales being appreciably larger in summer than in winter. If this criticism of the sole leather is valid, it should be easy for the American manufacturers to remedy the defect.

Printing and Binding Machinery.—American machinery has become an important factor in the printing and book binding trades in Edinburgh. Six large printing establishments have twelve American presses, an average of two each, for book and magazine work. The oldest and most famous house in the city has three. Other printing houses, doing general work, have also introduced American presses. Some of the book and magazine printers have, in addition to the presses, American folding machines, stitching machines, case-making (book-cover) machines, and backing machines. The leading printers express a very favorable opinion of all these classes of American machinery, and, notwithstanding the prices are at present comparatively high, the demand is likely to increase. This means much to American manufacturers in these lines, for, barring London, Edinburgh is the chief center of the printing industry in the United Kingdom. I have heard only one criticism—if I may use this term—of the presses, and that is that their maximum speed is greater than necessary. The backing and cover-making machines give entire satisfaction. The American stitchers introduced are as yet used only in binding the best class of books. The cheaper books, which are coarsely stitched, are sewn on German stitchers.

Cement.—A recent issue of an American trade journal contains a paragraph on the growth of the Portland cement industry in the United States, in which it said that—

"During the past year, the leading manufacturers of Portland cement have begun to cultivate systematically the export field, and there is no question that soon American Portland cement will be laid down in large quantities in many foreign markets."

Cement is extensively used in Scotland. The imports of this article at the port of Leith are annually from 55,000 to 65,000 tons. It comes chiefly from England, although Belgium furnishes a considerable quantity.

A commission agent called at this consulate a few days ago to make inquiry about American manufacturers of Portland cement. I gave him the names of several companies. If the article can be delivered here at a reasonably competitive price, it should soon get permanently into the market, as American roofing slates have done during the last ten months.

American Meat in Edinburgh.—The public health act of 1897, applicable to Scotland, contains provisions in regard to meat inspection which are more severe than the provisions of the public health act of 1875, applicable to England. The Scottish law not only gives the local sanitary officers full control over slaughter-houses, but also empowers inspectors to enter premises within the district of the local authority at any time, search any cart or vehicle or any barrow, basket, bag, or parcel, and examine any animal alive or dead or article intended for human food. If it appears to him to be unfit for human food, he may take it away to have it dealt with by a justice. The justice may condemn it and order it to be destroyed, and impose a penalty on the person to whom the condemned article belonged or in whose possession or on whose premises it was found. The department of sanitary and market inspection in Edinburgh was constituted on its present basis under the public health act of 1897, in May, 1898. During the past year, not only have the slaughter houses been under careful supervision, but inspectors have paid more than 6,000 visits to the butchers' and other shops. The quantity of meat seized or given up as unfit for human food was 149,163 pounds. One Canadian carcass was seized. Not a pound of American meat was condemned. Inasmuch as the butchers of Edinburgh handle a large amount of American chilled meat—the quantity of American chilled beef alone consumed in Edinburgh (not including Leith) averages 31,500 pounds per week—this evidence of its wholesomeness is noteworthy.

German Industrial Advance.—Louis Stein, commercial agent at Bamberg, writes as follows:

The German iron, machine, coal, and chemical industries are scarcely able to meet the demands made upon them. The prices quoted for shares of the more important of the textile factories show that this branch is also slowly growing again, after having suffered for a long time, chiefly from American competition. The development of the German copper trade is connected with the exceedingly favorable condition of the electric industry; the caoutchouc industry is also connected with the latter, and with the large output of cycles.

Great activity prevails in nearly every branch of manufacture. The inland market is unusually absorptive, and efforts are being made to recover in new territories what has been lost by some of the branches in the export trade—the textile industry, for instance.

Special reference should be made to the great activity of some of the German consuls. About a year ago, the well known German commercial writer, Dr. Von Vossberg-Reckow, stated in his essay on "Consular Reform" that the government of the United States could point with pride to the most efficient consular service, and that our way of gathering interesting news and giving information should be followed in Germany. Though a consular reform, properly speaking, has not been brought about in Germany yet, the hints thrown out by Dr. Von Vossberg-Reckow, and by some of the chambers of commerce within the last few years, have had a very salutary influence upon the activity of the German consular officers. In consequence of consular hints to German manufacturers, a strong effort is being made to enlarge the trade in German leather and shoe ware in the Japanese market. Interested parties in the United States should promptly take notice of this, for these are the very articles in which American exportation to Japan has been steadily growing. So far, the German export of leather wear to Japan has, on the whole, been confined to the better class of goods, as manufactured at Berlin and Offenbach.

Germany in China.—Consul Monaghan, of Chemnitz, under date of May 3, 1899, says:

No nation is better posted as to what is going on in China than is Germany, and no nation has taken greater care to provide for necessary ways and means for finding out facts. The Kaiser's brother, with quite an array of ships and men, has been kept in Oriental waters, with a view to being on hand in case complex contingencies should arise, out of which Germany might make a successful move. Reports from the East inform the public here that Prince Henry has just gone on board the "Gefion," at Shanghai, for a trip up the Yangtze Kiang to Hankau, a distance of 584 sea miles. The Yangtze Kiang is China's most important river. Navigable for ocean steamers, at high tide or under favorable conditions, as far up as Hankau, and for river boats hundreds of miles farther, it offers, as a glance at a map of China will show, traffic with an entire nation. Commerce on this mighty river hitherto has been in the hands of the English and Chinese. Germans hope to have a hand in all that goes up and down its waters in future. Two fine river boats, built for a German company, began to ply this summer between Shanghai and Hankau. Recent reports tell of a second company, in eastern Asia, eager to participate in the enormous freight and passenger traffic of the Yangtze Kiang, ordering a fleet of steamers. After the treaty of Simonoseki, Germany obtained concessions on the Yangtze Kiang at Hankau, the importance of which to foreign trade, but more particularly to German trade, it would be hard to measure. Their value is constantly increasing. Hankau is the entrepôt, so to speak, for central, northwest, and west China. Its traffic in goods, as far as figures have been kept by foreigners, has gone up to $50,000,000. The export of tea—fully half of the total—is, or was till quite recently, in the hands of the English and Russians; almost, if not quite, all the rest of the trade is in the hands of Germans. As the most important open port in the center of China, Hankau is regarded already as a connecting link in the Canton and Pekin Railway. It is looked upon as the terminus and principal station of the road projected along the Yangtze Kiang.

Germans see in these concessions at Hankau on the Yangtze Kiang the bases on which to build up enormous trade relations, not only along the river, but in the interior, and more particularly in the rich provinces of central and western China. Mercantile centers here see in Prince Henry's trip up the Yangtze Kiang to Hankau new proof of the Emperor's determination to do all he can to increase German influence in the East. Every effort is being made to make the best of every concession, no matter how small it is. Once the thin edge of the wedge is in, this empire finds ways and means, by patient labor, to enlarge the opening. If the Germans can buy wool in Australia and South America, cotton in the Carolinas and Texas, iron in Sweden, coal in England, and ship its manufactured goods to every corner on earth, there is no good reason why we should not outsell them. The things Germany exports, we make as good and as cheap, if not better and cheaper. If we must take China's tea and silk, let us sell China our engines, boots, shoes, cottons, agricultural and mining implements. Russia and China are developing their resources, and will want just such tools as have helped us to be successful. Among the 11,667 foreigners settled in China at the end of 1897 (the year previous had 10,885; 1894, 9,350), England led with 374 firms of 4,929 persons; the United States, 1,564 persons (1,439 in the year previous); Japan, 1,106 (852 a year before); Germany, 950. France has fallen off remarkably, viz., from 933 in 1896 to 698 in 1897. The only others worth mentioning are the settlements of Swedes, Norwegians, Spaniards, and Portuguese. The Russians and Dutch are very few. Under existing conditions and influences, Russia will not remain long in the rear.

Under date of April 18, Mr. Monaghan writes:

A director of the North German Lloyd was sent by the German government some time ago to study Kyau-chau and its contiguous territory, with a view to its exploitation with German capital and by German colonists. The report, which has been handed to the Kaiser, is said to be one of the most exhaustive of its kind ever written. It points out coal as one of the valuable possessions of the new territory, and says: "While it is not as good as England's, it will answer all purposes for shipping and industrial pursuits."

Foreign and Home Consumption of German Beer.—The German beer industry has grown year by year, and the increasing capacity of the establishments has made it necessary for the brewers to search for new markets where their overproduction could be disposed of, says U. S. Consul Max J. Baehr, of Kehl. The home consumption, of course, is depended on as giving the first and greatest chance to sell the different kinds of beer, but the larger brewers, especially those who increased the capacity of their establishments more or less after the style of the big American breweries, have had to find customers in foreign countries. Their efforts for some time met with good results, and Germany's beer industry had an export market for its products which seemed to be all that could be expected.

In the year 1885, the export of German beer reached its high-water mark, amounting in that year to 1,318,000 hectoliters (34,821,560 gallons), representing a value of 24,000,000 marks ($5,712,000). The next year, however, showed a decrease, and since then the export has gone down to about one-half of what it was in 1885. The reason given for this decline is that the countries which were Germany's best customers (France, Belgium, and the Netherlands) have increased their output sufficiently to nearly meet the home demand. The high duty placed on foreign beers by France has also had the effect of considerably reducing the import of German beers into that country.

In all those years, the export of German beer in bulk (barrels) has been greater, contrary to general belief, than in bottles.

German beer once had nearly a monopoly of the beer trade of South America; but there also, it is stated, the demand has decreased, while at the same time, according to trade papers, the demand for United States beer has increased. The decline of the German beer trade in Brazil alone during the years 1896 and 1897 is given as amounting to fully three-fourths of what the German brewers had exported to that country in former years.

It is a noticeable fact that, while the export has declined year by year, the production of beer in Germany has advanced steadily, showing that the home consumption has greatly increased. At present, the United States is the best foreign customer for German beer, importing in 1895, 522,138 gallons, and in 1896, 689,456 gallons. The export of beer from Germany to Venezuela, Japan, and China together did not in the years given amount to one-half the exports to the United States alone. Brazil and British India, as consumers of German beer, come next to the United States. The German brewing industry has strong hopes of entirely supplanting the English in Australia and other English colonies.

Exclusion of Certain American Products from France.—Under date of April 29, 1899, Consul Skinner transmits the following translation of a decree excluding certain American products from France. Although the decree was issued some months ago, it was only published in Marseilles on the date of its transmittal by the consul.

To the customs authorities: I transmit to the service the duplicate of a decree of November 30 last, which determines the measures to be taken to prevent the invasion of France by an insect known as the San José scale (Aspidiotus perniciosus), the presence of which has been noted at Hamburg in the shipments of American fruits.

In virtue of article 1 of this decree, trees, bushes, products of nurseries, cuttings, and all other vegetables or parts of living vegetables—also their debris—coming from the United States, are interdicted from entering or passing in transit through France, either directly, or through the bonded warehouses. This interdiction extends to cases, sacks, and other packing materials serving or having served in the transportation of the articles named.

The same decree stipulates in article 2 that when the presence of the insect shall have been noted in shipments or débris of fresh fruits, the shipment of said fruit and its packings shall be prohibited. Instructions will be furnished later concerning the special measures to be taken in applying article 2 in question.

I add that by a new decree of February 3, the dispositions of the decree above are extended to Algeria.

Steamship Line from England to Finland.—Consul Metcalf, of Newcastle-on-Tyne, under date of May 19, 1899, reports the recent establishment of a weekly line of steamers from that port to Finland, carrying passengers, mails, and freight. One steamer has already arrived at Newcastle with above 200 emigrants on board, en route for the United States.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 467. July 3.—Emigration in South America—Accidents to Workmen in France—*Mechanical Power in Germany—Seal Fisheries of Japan—*Pearl Fishing in Venezuela—*Water Filters for China.

No. 468. July 5.—United States Trade in China (Extensive Report).

No. 469. July 6.—*Heating and Cooking Stoves in Uruguay—American Fruit in Norway—Coffee in Jamaica—Conversion of Mexican Debt—*Direct Steamship Connection with Syria—*Sugar in Spain.

No. 470. July 7.—Port Works at Montevideo—French View of Philippine Situation—Canadian Canal Problem—*American Barber Chairs in Germany—Plan for Controlling Coffee Market—*Invoices for Turkey.

No. 471. July 8.—Mining in Szechuan—Manganese Ore in Japan.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

ENGINEERING NOTES.

A deep-sea diving boat, the invention of a Tunisian engineer, M. Piatti dal Pozzo, is said to have carried out a series of successful trials at Cherbourg. The craft is spherical, three meters in diameter, and is fitted with three screws and a species of combined dredge and grapnel that can be used to pick up cables or other objects. So far the experiments have been carried out at depths varying down to 170 feet. The inventor announces his intention of searching for the hull of the "Alabama," which was sunk opposite Cherbourg by the "Kearsarge" during the American civil war.—Shipping World.

Illuminating shells for lighting areas of ocean in life-saving work or to get the range of the vessels of an enemy have been devised by an American company. The shell used is a hollow cylinder made of steel tubing, and charged with calcium carbide, which, coming into contact with water, generates acetylene gas. The end of the shell remains above water, and at this end are burners lighted by an electric device contained in the shell. It is claimed that the light produced is of 1,000 candle power, and cannot be extinguished by water. The shell is to be shot from a gun to the distance of two miles, and floats with one-quarter of its length above water.

"The power of Niagara," says Prof. R. B. Owens in Cassier's Magazine, "has been estimated at about 7,000,000 horse power—greater probably than the physical force the whole human race is capable of continuously exerting. At present about 350,000 horse power is to be developed on the American and Canadian sides, or about five per cent. of the total power available—not enough to perceptibly diminish the flow over the falls. However, should the whole be utilized, leaving the rocky river bed dry and bare, we would but be substituting a wonderful cataract of etheric energy for the splendid flow of gravitational matter so justly famed. Which spectacle would present greater beauty would depend upon the individual. To those who trace in imagination the course of a beam of sunlight, as it buries itself in the ocean, rises in cloud, and falls again in grateful shower over grain field and vineyard, filling brook, and swelling river, and finally tumbling through mighty turbines and silently streaming from the polished slip rings of stately dynamos, bursting again into wholesome sunlight, to brighten the homes of hundreds, the substitution would but be the completion of a full cycle of usefulness and beauty."

The latest monthly report of the chief naval constructor, on the progress which is being made on all classes of vessels now building for the navy, gives the degree of completion of the different vessels as follows: Battleships—"Kearsarge," 91 per cent.; "Kentucky," 89 per cent.; "Illinois," 65 per cent.; "Alabama," 85 per cent.; "Wisconsin," 70 per cent.; "Maine," 6 per cent.; "Missouri," not started; "Ohio," 5 per cent. Sheathed cruisers—"Albany," 80 per cent. Monitors—"Arkansas," not started; "Connecticut," 6 per cent.; "Florida," 7 per cent.; "Wyoming," 8 per cent. Torpedo boat destroyers—"Bainbridge," 10 per cent.; "Barry," 10 per cent.; "Chauncey," 10 per cent.; "Dale," 7 per cent.; "Decatur," 7 per cent.; "Hopkins," 19 per cent.; "Hull," 19 per cent.; "Lawrence," 21 per cent.; "Macdonough," 20 per cent.; "Paul Jones," 15 per cent.; "Perry," 15 per cent.; "Preble," 15 per cent.; "Stewart," 2 per cent.; "Truxton," 3 per cent.; "Whipple," 3 per cent.; "Worden," 3 per cent. Torpedo boats—"Dahlgren," 97 per cent.; "T. A. M. Craven," 94 per cent.; "Stringham," 77 per cent.; "Goldsborough," 70 per cent.; "Bailey," 56 per cent.; "Bagley," 8 per cent.; "Barney," 8 per cent.; "Biddle," 8 per cent.; "Blakely," 30 per cent.; "DeLong," 30 per cent.; "Nicholson," 33 per cent.; "O'Brien," 33 per cent.; "Shubrick," 3 per cent.; "Stockton," 29 per cent.; "Thornton," 29 per cent.; "Tingey," 21 per cent.; "Wilkes," 7 per cent. Training vessel for Naval Academy—"Chesapeake," 90 per cent. Submarine torpedo boat—No. 1 "Plunger," 85 per cent.

In a communication sent to The Herald from Lowell the writer denies Boston's right to the claim of having the largest railroad station in the world, and calls attention to the massive structure erected by the Great Indian Peninsula Railway Company at Bombay. He asserts that this terminal structure is not only handsomer and more expensive than the one in this city, but that it excels it in dimensions. Careful research failed to disclose the existence of anything reliable regarding the dimensions of the terminal at Bombay, and it was with the hope of securing authentic information in this direction that The Herald addressed a communication to the chief engineer of the Peninsula Railway, with the request that he furnish such statistics of the station as would satisfy the public here as to its exact size, cost, and area covered. A courteous reply came to hand in the last Indian mail, accompanied by a blue print bearing the signature of Engineer Compton, and attesting to the accuracy of the statistics furnished. They are presented with those of the South station, for the purpose of ready comparison, and are as follows:

	Bombay station.	South station.
Area of headhouse site (square feet)	56,800	85,790
Number of floors in headhouse	3	5
Width of end platforms (feet)	84	90
Number of platforms	4	23
Length of train shed (feet)	600	720
Widest span (feet)	116	228
Width of train shed roof (feet)	270	570
Number of tracks	8	32
Baggage rooms (square feet)	7,150	27,500
Waiting rooms (square feet)	15,412	18,300
Refreshment and dining rooms (square feet)	8,560	10,500
Cost	$1,190,000	$17,500,000
Date of execution	14 years	2 years
Total site (square feet)	319 000	506,490

In considering the cost of the Bombay station, the fact should not be lost sight of that labor in India is fully 75 per cent. cheaper than it is here, and, further, that the value of the land occupied was probably secured at a price considerably under that paid by the Boston Terminal Company. In regard to the date of execution, it might be claimed, in the case of the Boston terminal, that a great deal of work remains to be done before it will be in complete operation, but this does not change the fact that it was made ready for occupancy within two years after the work of construction was started.—Boston Herald.

ELECTRICAL NOTES.

On June 5, a freight train on the Flint & Pere Marquette Railway was wrecked near Rose Center, Mich., by the explosion of an oil tank car, said to have been struck by lightning. The train was crossing a bridge at the time, and nine cars and the bridge of 200 feet length were totally wrecked, so that traffic was delayed for several days.

Dr. Friedlander, of Wiesbaden, says Electricity, recommends galvanism to relieve the pain and irritation and to reduce the swellings caused by the bites of insects. The negative electrode is placed over the seat of the sting. It is effective in the case of gnat and wasp stings, and would probably also be of service in poisoning by the stings of tropical insects.

Statistics show that in 1893, 3,030 lamps met the requirements of consumers of electric light in the city of Brussels. At the present time there are 66,000 lamps. In consequence of the constantly increasing use of electricity, the city has been obliged to enlarge its works. It is now proposed to acquire five new vertical engines of 1,000 horse power each, to be placed in works already supplied with five horizontal machines of 500 horse power each.

An electrical siren has been devised and is said to have been perfected at Ottawa, Canada. It is stated that this siren may take the place of electric bells, and may come into general use for fog signals at sea and along the shores where such signals are now in use. The siren can be placed at a point inaccessible to the ordinary steam plant now used in fog signaling, and can be operated by wires connecting the power at almost any distance. The sound is produced by the vibration of a diaphragm at the base of a horn.

Prof. Juellig, in an article in the Zeitschrift fuer Elektrotechnik, gives the maximum spans possible for wires of different materials, on a basis of a factor of safety of 4. For cast steel wire, 3·42 miles; for silicum bronze, 1·56 miles to 1 mile, depending on the quality; for wrought iron, 1·02 miles; and for soft copper, 0·53 mile. These maximum spans are independent of the cross section of the wire, for although the weight of the wire increases with the cross section, its strength increases in the same proportion. These spans do not allow for wind pressure, or for snow or ice. The figures are of interest as showing the possible limits.

In some evidence recently tendered in an application to Parliament to build a new underground line, the Baker Street and Waterloo Railway, some interesting figures relating to the cost of underground railways in London were given as follows: North-west London Railway (not yet built), £485,000 per mile; Baker Street and Waterloo Railway (projected), £575,000 per mile; Central London Railway (under construction), £585,000 per mile; Great Northern and City Railway (under construction), £653,000 per mile. In all the above mentioned lines the tunnels are of circular section and iron lined, and operated by electricity.—Mechanical Engineer.

The power station of the Huntington Railroad, of Huntington, L. I., is operated by gas engines. This road is three miles long, operating one car in winter and three in summer. As there is a steep gradient on the line, the load is variable. The power house equipment consists of two Westinghouse three-cylinder vertical gas engines, each of 50 nominal horse power, taking their gas supply from the adjacent works of the local gas company. Each engine drives a 27½ kilowatt Westinghouse four-pole 550-volt generator. A storage battery of 265 cells is used to equalize the load. It is stated about 46 cubic feet per car mile of gas is used. The car mileage is about 200 per day.

A continuous drought is something to be expected on the Pacific coast of the United States, and the failure of the water supply for power for the turbines is a serious thing for electrical companies. They had a failure of supply at Austin, Texas, where the Colorado River watershed had practically been without rain for eight months. The river has a dam 60 feet high and the penstocks to the turbines are 8 feet below the crest; should the water fall below this the turbines cannot be worked, though the water behind the dam may be 50 feet deep and run back for 30 miles. Under such conditions there was nothing to do but to procure candles, lamps, etc., and shut down the dam until the water again rose over the mouths of the penstocks.

A curious fact is, says The Electrical Review, of New York, brought to light by one of the gentlemen connected with the Automobile Club in that city. It is that no livery stable will store an automobile on account of the horsemen's prejudice against these vehicles. Consequently the owner of an automobile has to provide a private storage place for it, at considerable trouble and expense. This sort of opposition to improvement is reminiscent of the early days of the steam engine, when several of them were destroyed by laborers jealous of the new invention. If the livery stablemen were wise, they would begin now to put in stalls and charging accommodation for electric vehicles to replace the horses and carriages that a few years' progress will send to the limbo of forgotten things.

A commencement was made last year toward utilizing the considerable water power of the Nice district for electrical purposes. A company was formed which at once took in hand the Var, at the point called "La Mescla," where it is confined in a narrow gorge. A tunnel was pierced through the solid rock of some 600 meters in length into the Vallon de Fenouillet, where a large reservoir has been formed, and whence the considerable fall thus obtained is about to be utilized by the Electric Tramways Company, which is literally taking possession of the whole littoral, to the great disgust of this aristocratic neighborhood, and more especially of Cannes, where but one road exists to join the east and west portions of the place, and that a narrow one at the best. Protests, says a consular report, are rife, but have proved useless so far, as far as Cannes is concerned, and at Nice a great effort is being made to save the beautiful boulevards, shaded by fine trees, and bordered by handsome houses, from this invasion.

SELECTED FORMULÆ.

Angostura Extract for Bitters.—Dubelle gives the following formula, which he says makes an excellent soluble wine bitters extract:

Angostura bark	16 ounces.
Bitter orange peel	8 "
Canada snake root	8 "
Calisaya bark	8 "
Virginia snake root	8 "
Gentian root	4 "
Galangal root	4 "
Sweet flag	4 "
Cardamom seed	2 "
Cinnamon	1 "
Cloves	1 "
Coriander	1 "
Mace	1 "
Alkanet root	2 "
Deodorized alcohol	6 pints.
Distilled water, to make	1 gallon.

Grind all the drugs to a fine powder and moisten with 2 pints of alcohol, pack in a water-bath percolator, and having mixed the remainder of the alcohol with 4 pints of distilled water, pour enough of the mixture upon the drugs and let stand in a warm place 4 days, shaking several times a day; then pour the remainder of the mixture upon them, heat very moderately, and after two hours begin to percolate, adding distilled water to the drugs, and continue the percolation until exhausted. Reserve the first 7½ pints that pass, evaporate the remainder of the percolate to ½ pint, and add to the reserved percolate to make 1 gallon. To make Angostura wine bitters, mix 3 fl. ounces of this extract with 1 gallon sweet Catawba or pure sherry wine and 2 fl. ounces of glycerine.

The same author gives the following for "Stoughton Extract:"

Gentian root	16 ounces.
Virginia snake root	8 "
Bitter orange peel	16 "
Sweet flag	8 "
Cardamom seed	4 "
Red saunders	4 "
Coriander	2 "
Cloves	1 "
Deodorized alcohol	6 pints.
Distilled water, sufficient to make	1 gallon.

Prepare and percolate as above.

To make Stoughton Wine Bitters, mix 3 fl. ounces of this extract with 1 gallon sweet Catawba or sherry wine and 2 fl. ounces of glycerine.—Pharm. Era.

Lemonade Essence.—

White sugar	600 grammes.
Distilled water	400 "
Citric acid	40 "
Orange flower water	100 "
Alcohol	100 "
Oil lemon	10 "

Dissolve the sugar in the water and to the sirup add the citric acid dissolved in the orange flower water. Filter and add the oil of lemon dissolved in the alcohol. To make lemonade add 100 grammes of this essence to 1 liter of water or carbonated water.—From Hagar.

Smelling Salts.—

1. Water of ammonia 2 ounces.
   Oil of lemon 7 drops.
   Oil of lavender 2 "
   Oil of bergamot 4 "
   Ammonium carbonate, a sufficient quantity.

Sift out the very fine and the very coarse pieces of the ammonium salt, using only those which are of nearly uniform size. Use as many of these as will go into the bottle, and fill with a mixture of the other articles.

2. An old time favorite composed of—

Water of ammonia	4 ounces.
Oil of rosemary	15 minims.
Oil of lavender (English)	15 "
Oil of bergamot	8 "
Oil of cloves	8 "

Pieces of sponge are placed in a bottle and saturated with this mixture.

3. Preston salt is a mixture of ammonium chloride and freshly slaked lime, to which a suitable perfume may be added. The mixture develops small amounts of ammonia continually until decomposition is complete, which is sometimes several years.

4. Another example of the generation of ammonia by the decomposition of ingredients of a smelling salt is given by Snively in the following formula:

Ammonium chloride	3½ ounces.
Potassium carbonate	4½ "
Oil of lavender	½ "
Oil of lemon	3 drachms.
Oil of cloves	15 minims.
Oil of bergamot	1 drachm.
Water of ammonia, a sufficient quantity.	

Triturate the chloride and carbonate well together; then add the oils, and finally enough water of ammonia to slightly moisten the mass.—Druggists' Circular.

At a meeting of the Society of Manufacturers of Mineral Waters, in Germany, the following methods of killing the smell of rubber rings were proposed, says the Zeitschrift für die gesammte Kohlensaure Industrie: Treating the rubber with solutions of caustic potash and caustic soda; treatment with potash or soda, since caustic potash and caustic soda are believed to injure the rubber; boiling with alkaline soaps; boiling with lescive phenix—calcined soda with water glass; and lastly, after treatment with soda, leaving the rubber for some time in a solution of cooking salt (10 to 15 per cent.)

Sealing wax indifferent to alcohol may be prepared as follows: Yellow wax, 500 parts; carnauba wax, 100 parts; and paraffin, 100 parts, are melted together, and to this a mixture of 500 parts of red oxide of lead and 200 parts of prepared chalk added, the whole then heated under continuous stirring until the mass begins to thicken. This wax is employed for sealing containers of alcoholic liquids, and is best applied by warming the wax in a small tin pan having a pour-out running to a sharp point, and pouring from this slowly upon the bung, cork, etc., to be sealed.—Drog. Ztg.

MAGNETISM ILLUSTRATED BY AIR CURRENTS.

C. L. WEYHER, to whom we already owe the invention of some curious experiments with "whirligigs," or rotators, has recently devised some others for the purpose of reproducing, by means of rotary movements, all the known properties of magnets.

These pseudo-magnets consist simply of paper wings fastened to wooden axes, and they behave exactly the same as bar magnets when they are rotating. A pair of them in operation forms a centrifugal pump, drawing in the air at the ends and expelling it at the center part. Two rotary currents moving in the same direction are produced. If observed from the ends of the axis, they follow the direction of a right-handed screw in one half and of a left-handed screw in the other. Besides these rotary currents axial currents are started which move in opposite directions toward the center. The general direction of the currents is shown in Fig. 1, which represents two cardboard cylinders with arrows marked upon them, showing the direction of the rotary currents and of those along the axis. These two cylinders will give an idea

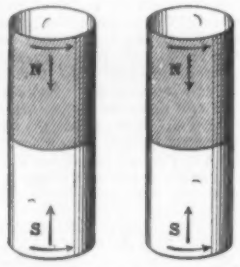


FIG. 1.—PSEUDO BAR MAGNETS.
The arrows show the direction of the currents.

of the "bars" of the rotary system. Half of each represents the north pole and half the south pole of an ordinary bar magnet.

If we consider the direction of rotation, it is clear that if the two north poles are opposite, the air currents will meet and flow into each other. This will cause crowding of the air and over-pressure, and if they are free to move, the bars will repel each other and separate. If we turn them so as to place a north pole opposite a south pole, the effect will be reversed, and the air currents between the two bars will move outward, rarefying the air and diminishing the pressure, and thus making the two cylinders tend to approach each other. The same result is obtained when two tops are spun side by side. If the direction of rotation is the same, the tops will separate; if it is opposite, they will approach.

The well known magnetic rule that unlike poles attract and like poles repel each other is always fulfilled by these devices. Fig. 1 shows theoretically that this must be so. It may easily be demonstrated by setting two of them in motion that there is attraction or repulsion, according to whether a north pole is presented to a south pole or to a north one, that is to say, according to the direction of the currents.

Reference to Fig. 4 will show the appearance of the bar-magnet whirligig. It is simply a small wooden stick the size of a lead pencil, with four or six paper wings glued to it. The stick is suspended from a short vertical shaft having a pulley upon it by means of a

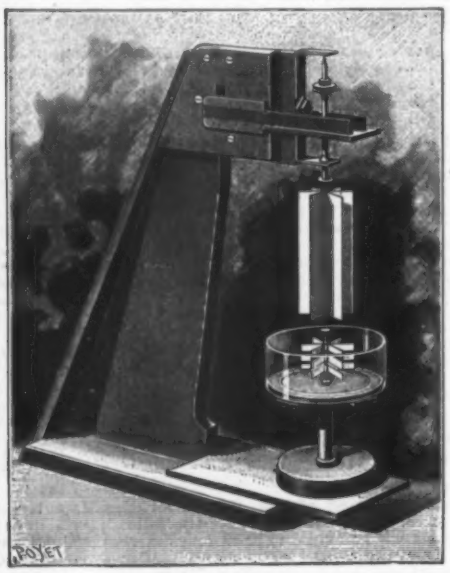


FIG. 2.—PAPER BAR MAGNET ATTRACTING THREE SMALL PINWHEELS.

hooked joint, so that it is free to move in any direction while revolving. Strings pass around the pulleys and connect with small electric motors, which furnish the rapid motion necessary. When the "bars" are set in motion with opposite poles facing each other (which is accomplished by whirling them in opposite directions), they attract each other noticeably. A change in the polarity (by changing the direction of rotation of one of them) causes them to repel each other.

By fastening the wings of one of the "bars" to a sleeve they may be moved along the axis. If the left hand "bar" is raised, as in Fig. 4 (3), and the poles then facing each other are opposite, they will attract each other, as with real magnets. When a vertical "bar" is placed opposite a horizontal "bar," as in Fig. 4 (4), the vertical one will be drawn toward the other and held in an inclined position, or, if the poles are changed, it will be repelled. Numerous experiments may be tried in this way by making various small changes.

It is well known that if a magnet is cut into any number of pieces, each piece becomes a complete magnet in itself and has two poles. This is also the case with the whirligig "bars." The center of attraction in a real magnet is a little back of each pole. In like manner the whirligig "bar" has a maximum attraction a certain distance from its ends, since the air is set in motion not only by its ends, but along its whole length. A neutral line also exists in real bar magnets, and this is likewise to be found in the whirligig imitation. If a perpendicular "bar" at rest is approached to a short horizontal "bar" in motion (Fig. 4, 4), it will turn in one direction if placed at one end, in the opposite direction if at the other end, and not at all if at

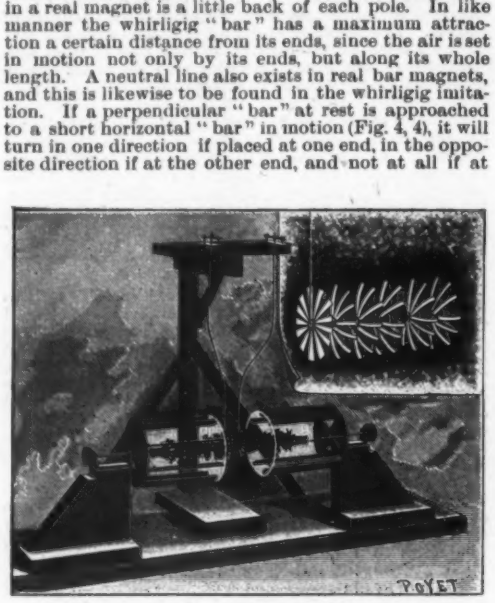


FIG. 3.—STATIONARY PERFORATED PAPER BAR MAGNETS OPERATED BY MOVABLE DRUMS.

the center, because the forces tending to turn it in opposite directions will be equal, thus making a neutral zone.

Fig. 2 shows a special apparatus for another experiment. Three small wheels are mounted on a pin below a "bar" and held at first while the latter is set in motion. As soon as they are set free the "bar" draws them, and the first one rises to the top of the pin, quickly followed by the second and third. It is an exact imitation of the chain of iron nails that may be hung from an ordinary magnet, each nail becoming a maguet and drawing the next one.

The attraction at the end of a "bar" and the neutral zone may also be shown very neatly with the aid of the apparatus illustrated in Fig. 5. The "bar" is surrounded with wire gauze, outside of which is a semicircular hood for the purpose of increasing the circular movement of the air, which is always weaker than the movement longitudinally. A small wheel is placed beside the "bar" and is so mounted that it can slide back and forth easily besides rotating upon its axis. If this wheel is at one end of the "bar" when the latter is set in motion, it will be drawn toward it; if it is in the middle it will not move, and if it is at the other end it will be repulsed; everything, of course, depending on the direction of rotation shown by the arrows.

The objection may be made that, in the reproduction of these phenomena, the pseudo-magnets are in motion, while with steel magnets, the magnet bars are at rest. M. Weyher makes reply by modifying the whirligigs. He incloses them in glass drums and makes the "bars" of a number of small paper wheels resembling daisies, which are mounted on a light axis of wood. (See Fig. 3.) If the drums are turned in the same direction, the "bars" are seen to attract each other, while if in opposite directions, they repel. The rotating drums set up air currents, which penetrate the small pinwheels and cause the "bars" to move.

An imitation of the lines of force of magnets may be had also. All that is needed for this is some fine sawdust sprinkled over a sheet of paper which is placed under a horizontal "bar." When the "bar" is rotated, the sawdust will act the same as iron filings under the influence of a magnet, accumulating at each end and leaving a bare place in the middle.

These experiments are very interesting and suggestive. They are successful in liquids as well as in air, and in very rarefied air also, if the speed of rotation is increased. The question is: What philosophical conclusions may be reached from them? M. Weyher says, "How is it possible not to perceive the connection existing between the ether of the physicists, however

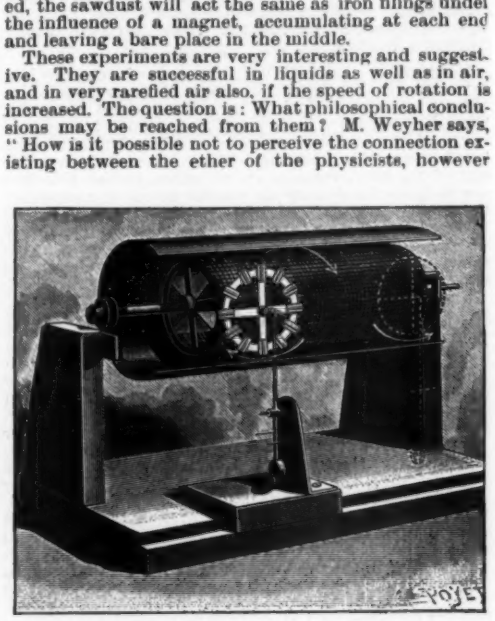


FIG. 5.—"BAR" ATTRACTING A MOVABLE WHEEL AT ITS ENDS AND PRODUCING NO EFFECT IN THE MIDDLE.

rare it may be and what may be its essence even, provided that it is material, and whirling air currents such as I have described? The ether occupies all space and is found inevitably between all the molecules of bodies. We see the celestial spheres turning in space, and consequently the ether which penetrates them must turn with them and receive their whirling motion." We find this rotary motion everywhere, and perhaps it is the origin, as illustrated by M. Weyher's whirligigs, of the phenomena of magnets. M. Weyher is not the first to uphold this theory, and he has at least given some weight to it by the above curious analogies and most interesting experiments.

We are indebted to La Nature for the illustrations and description.

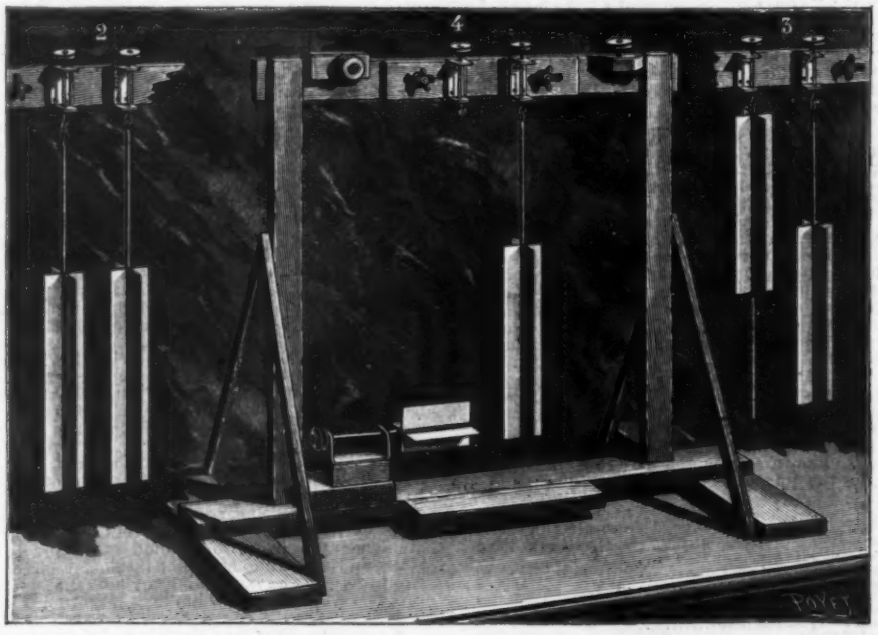


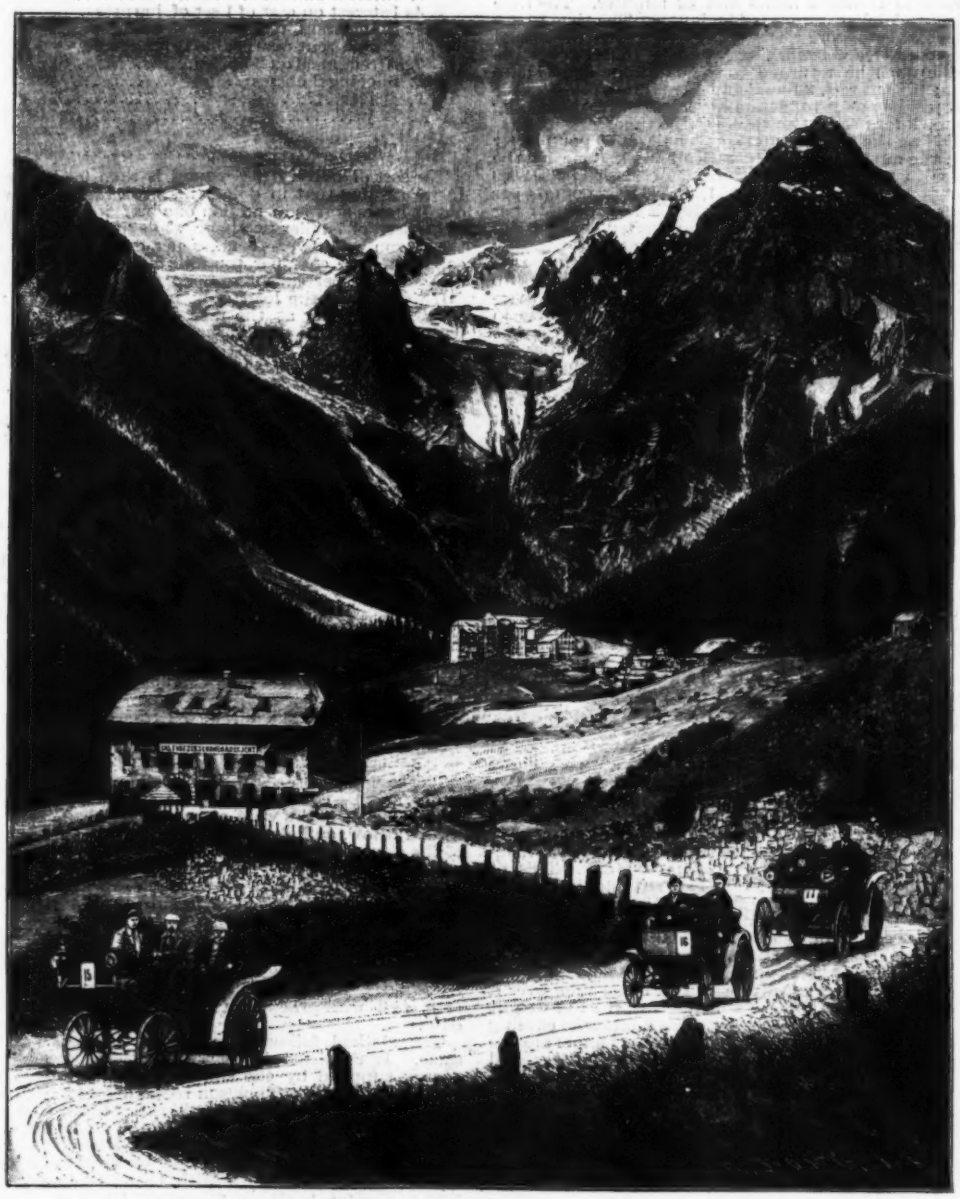
FIG. 4.—2. PARALLEL "BARS," SHOWING ATTRACTION OR REPULSION ACCORDING TO THE DIRECTION OF ROTATION. 3. ADJUSTABLE "BARS." 4. VERTICAL AND HORIZONTAL "BARS."

Condensed "Separated" Milk.—With such elaborate and drastic legislation for the protection of milk consumers as we possess, says The Medical Press, it really appears odd that foreign merchants should have been left a free hand in pushing the sale of a pseudo-condensed milk, the use of which in the alimentation of infants is attended by the gravest consequences to health and life. . . . To feed a young infant upon such milk is to condemn it inexorably to rickets, tuberculosis, or other diseases of malnutrition. We see no objection whatever to a proviso that the label shall comprise a statement in bold characters to the effect that the product is not intended for the food of infants. If, as the manufacturers pretend, they do not intend it for such a purpose, this statement will not interfere with the legitimate sale, while a too economical mother who made use thereof, in spite of this warning, would

lay herself open to the charge of willfully withholding proper nourishment from her infant. To oblige the vendors merely to state plainly on each box the exact nature of the contents will, in any event, be a step in the right direction; but in view of the harassing restrictions placed on the sale of such a production as margarine, which, under no circumstances, can prove harmful if properly prepared, it seems absurd to authorize the sale of skimmed milk without making perfectly clear that it is absolutely unsuitable as an article of diet for young infants.

AN AUTOMOBILE JOURNEY IN TYROL.

SEVERAL interesting bicycle and automobile races were run for prizes offered by the Oesterreichische Touringklub and the Oesterreichische Automobilklub for the best journey through southern Tyrol. The route prescribed embraced the most magnificent and at the same time the most dangerous portions of this mountainous region. The start and finish of the automobile race was the Trafoi Hotel, situated at an elevation of 1,541 meters (5,054 feet). The course prescribed was 520 kilometers long (322·40 miles); the time allotted, three days. The object of the race was to demonstrate the practical value



THE START OF THE AUTOMOBILES FROM THE TRAFOI HOTEL.

of the bicycle and automobile for touring and for traveling in general.

During the day it rained slightly, and it was not until evening that the clouds were blown away. The moon rose and shed her wonderful silvery light over the huge snow fields and ice walls of the magnificent passes. Down toward the base of the Ortelsberg stood the seven-storied Hotel Trafoi, throwing its light far into the valley and on the mountain side, whose winding roads the automobiles had to ascend in their nocturnal journey. The guests had all gathered in front of the hotel, excitedly awaiting the arrival of the automobiles, for Trafoi was the rendezvous of the six contesting carriages, three of which had journeyed overland from southern Germany, and three from Vienna. The first group consisted of Baron Theodor Liebig, Gottlieb Daimler, the well known maker of motor carriages, and Baron Passus, who at the last moment was compelled to withdraw. The second group was also finally reduced to two (Hofsekretär Dr. Edmund Suchanek and Adalbert Herrman) because the carriage of one of the contestants had not been completed in time. The greatest interest attached to the Benz carriage, of Baron Liebig, which had to travel from Koblenz, a five days' journey, of 700 kilometers (434·7 miles), to Trafoi. The excitement reached its height when, shortly after noon, a dispatch was received stating that Baron Liebig had reached Landek at 12 M. At six o'clock in the evening the Baron and Gottlieb Daimler, accompanied by his Viennese engineer-in-chief, Herr Bierenz, arrived at Neu-Spondinip, and were later met by Dr. Suchanek and Adalbert Herrman. All four carriages then continued the journey together along the Stilfserjochstrasse, branching off from Spondinip. Toward nine o'clock in the evening, they passed through the fortress gate of Gomajoi, and soon after the flashing lights of their acetylene lamps could be seen from the hotel. A shout from a hundred throats rang down into the still valley, and rockets shot up into the sky. In this manner the hotel guests celebrated the completion of the first automobile journey over the Tyrolean mountains. A few seconds later the well known tones of a horn were echoed through the forest, nearer and nearer came the puff, puff of a laboring motor, and, suddenly, a carriage shot out of the dark fir trees, described a graceful curve at full speed, and stopped in front of the hotel entrance. It was the speedy, lightly-built racing automobile of Baron Liebig. Soon after came Dr. Suchanek, Adalbert Herrman, and Gottlieb Daimler and Herr Bierenz.

Before beginning their competition, the motor carriages made an excursion to Stilfserjoch, which required one hour and a half. After this feat, it must be confessed that the days of the "Stelviapost" are numbered.

All the motor carriages were built for use only on level ground, and not for mountain-climbing; for this reason, the three days' tour must be regarded as an unparalleled and bold undertaking, which must certainly prove epoch-making in the future rôle played by the automobile in mountain traffic.—Moderne Kunst.

Destruction of Iron Water-pipes by Gases.—According to Stahl und Eisen, says The Engineering and Mining Journal, the Royal Iron Works at Gleiwitz, in Silesia, had supplied some 8 cm. pipes of cast iron for connecting a pumping station near Beuthen with the water reservoir, which stands 11 m. above the station. The conduit has a length of 2 km. Two years later the pipes began to leak over their whole length, and on examination it appeared that they were pitted. The holes were all arranged in a line corresponding to the upper part of the pipes when in position; the sides and lower parts had not suffered at all. The holes resembled large irregular pin pricks, tapering toward the outside. It was clearly an action of gases. There was nothing remarkable about the iron, which contained 3·24 per cent. of carbon (including 2·59 per cent. of graphite), 0·34 per cent. of phosphorus, 0·03 per cent. of sulphur, 1·37 per cent. of manganese, 3·44 per cent. of silicon, and a little nickel and copper; neither was there any peculiarity about the water. Iron will dissolve in water, more especially in places where air and water alternate in their attacks. In this instance the pumps were in action during four periods daily, each of one hour. The second case concerns St. Johann-on-the-Saar, which takes its water from the sandstone overlying the carboniferous strata of the Saarbruck district. The water is soft and very pure; but it became dirty brown, quite unfit for drinking and washing, and destroyed both the pipes and the water meters. It was manifest that iron caused the trouble; but the water at the source did not contain any iron at all. It was afterward ascertained that the water contained 126 cubic centimeters of carbonic acid per liter, free or as bicarbonate—an amply sufficient amount to account for a great deal of corrosion. Attempts to remove the carbonic anhydride by means of aeration failed; it is now proposed to try atomizers. Meanwhile, a considerable improvement has already been secured by keeping the pumps at work night and day, so that the water does not remain in contact with the iron longer than is absolutely necessary.

OPERATING COSTS OF HORSE AND ELECTRIC DELIVERY WAGONS IN NEW YORK CITY.*

By G. F. SEVER and R. A. FLIESS.

DURING the last three years many descriptive articles relating to the automobile have appeared in the technical press, but up to the present time there has been published no definite data which might be used to indicate whether or not electric operation possessed any advantages. Hence both the general as well as the technical public could form no definite opinion as to the benefits to be derived from the use, in any particular class of service, of either an electric or a horse system.

The purpose of this paper is to present the results of an investigation carried on during the past year in the city of New York, of the operating costs of the horse and electric delivery service as at present instituted by the large department stores. This investigation formed part of a graduation thesis in the Electrical Engineering Department of Columbia University.

The present status of the art does not permit of an exhaustive comparison, as some of the data now presented will probably be entirely altered by the rapid developments which are taking place, the art progressing quite similarly to that of the electric railway. That which can be done most successfully is to compare the cost of maintenance of the two above-mentioned systems, and if to-day an electrical system costs less to operate and keep than a horse system, it is simply a question of a short time as to the replacement of the horse by the electrical method. Of course in considering the economy of any system, depreciation enters largely as a factor; but, in case of any new system such as is under consideration, the determination of the depreciation of any of the various parts or of the system as a whole would be difficult, and for its solution would require long continued service and close observation. Owing to the short time that the automobile has been in the field in commercial competition with the horse, it has been impossible to collect a sufficient amount of data on this point to make its introduction of value in drawing a comparison between the total operative costs of the two systems.

SECTION I.

SOME DATA ON HORSE DELIVERY SERVICE.

The work done by a horse in moving a vehicle over level ground consists in overcoming resistance to motion due to friction; it may be conveniently expressed in foot-pounds. When grades are encountered, the number of foot-pounds of work performed in the same distance will increase. This additional work is necessary to overcome the force of gravity. When on a descending grade, the horse does work in resisting the tendency of the vehicle to accelerate. Hence, when in motion, the horse is continually doing work. The exact amount of work performed by a horse in a day is a very variable quantity. It depends upon many factors, some of which are:

1. Kinds of road surface—macadam, asphalt, etc.
2. The condition of roads traveled over.
3. Topography of the country passed through.
4. Nature of the load.
5. Distribution of the load on the wheels.
6. The horse itself.

The horse is not an automatic machine that can be designed to perform a given amount of work with a given efficiency. It is, on the contrary, a most variable, and at times willful, source of motive power. The breed, state of health, temperament, environment, adaptation to the load, etc., affecting in a greater or less degree the amount of work that can be performed in a day by any individual horse. The problem, therefore, of determining the amount of work done by a horse, under any but very regular and systematic conditions, is one of great complexity. But under regular conditions the amount of work performed may be quite closely approximated. It is proposed in this section to give the results obtained in an investigation which was undertaken to determine, as closely as possible, the average amount of work performed daily by a certain lot of horses engaged in the delivery service of a large dry goods store in New York city.

It may be well to explain in some detail the exact nature of the work required of this class of horses. The large "department stores," as they are now called, have to keep in operation winter and summer, irrespective of the weather, a delivery service which must be as regular in the fulfillment of its functions as the local steam railroads and street railway systems are in the execution of their obligations. The nature of the service necessitates a highly organized system of delivery by means of small units capable of carrying 700 to 800 pounds over short distances and with considerable speed. This problem has been met and solved by these stores through the introduction of a horse delivery service composed of many small units, each one of which has its special district to cover and a certain time schedule to follow.

* A paper presented at the sixteenth general meeting of the American Institute of Electrical Engineers, Boston, June 28, 1899.

To illustrate more clearly the method pursued, we will follow one of these units through its daily routine. Let us consider the case of a wagon making three deliveries a day. The first delivery starts from the stable at 8 o'clock in the morning and arrives at the store a few minutes later—the stable, in most cases, being not far from the stores. Arrived at the store, the wagon receives its load, which varies from day to day, but which will average the year round not over 800 pounds. This load may be taken as the average load on all trips as the wagon leaves the store. The load decreases as deliveries are made, so that theoretically when the wagon has reached the store again, it should be without load. This, however, seldom happens in practice, as there are many C. O. D. packages in each delivery that must be returned to the store, as collection could not be made. Also packages sent out on approval are called for and brought back to the store on each trip. Hence, the load, as a general thing, does not entirely disappear before the wagon reaches the store at the end of any one delivery. It may be safely assumed, however, that the average load carried throughout any trip will not be more than 500 pounds. The load having been received, the wagon starts out to deliver its packages.

The following table gives for a certain store the division of the city into what may be called unit districts, each store having, of course, its own particular scheme of subdivision, this depending upon the volume of its business.

TABLE I.

1.	Canal	Street	to	Battery,	east	and	west	.....	2	deliveries a day.
2.	"	"	"	19th Street,	east of	Fifth	Avenue,		3	" "
3.	"	"	"	19th	"	west	"	"	3	" "
4.	20th	"	"	40th	"	"	"	"	3	" "
5.	41st	"	"	59th	"	"	"	"	3	" "
6.	60th	"	"	75th	"	"	"	"	3	" "
7.	76th	"	"	90th	"	"	"	"	3	" "
8.	91st	"	"	105th	"	"	"	"	2	" "
9.	106th	"	"	125th	"	"	"	"	2	" "
10.	126th	"	"	145th	"	"	"	"	2	" "
11.	20th	"	"	59th	"	east	"	"	3	" "
12.	51st	"	"	80th	"	"	"	"	2	" "
13.	81st	"	"	110th	"	"	"	"	2	" "
14.	111th	"	"	145th	"	"	"	"	2	" "
15.	All above 145th Street, east and west.....								1	

It will be observed that on the longer trips only two deliveries are made a day, while above One Hundred and Forty-fifth Street only one delivery is made. This latter is an all-day route, and the horse that goes up one day comes back the next—horses being changed at the local stable of this particular store near One Hundred and Eightieth Street.

Let us suppose that the wagon has started on trip No. 7, then it will go from that store to Seventy-sixth Street without stopping, the first delivery being made in Seventy-sixth Street. To make it easier for the horse and to facilitate the delivery, the driver does what is called "backloading." This means giving a number of packages to his helper or delivery boy to distribute on foot, while he drives to another street, makes some deliveries and meets his boy again at some pre-arranged point. By this method the horse is saved a great deal of work and the time of delivery is much shortened. After the deliveries are all made on the way up, say between Eighth Avenue and Amsterdam Avenue as far as Ninetieth Street, the end of this route, then the wagon comes down, delivering between Amsterdam Avenue and Riverside Drive to Seventy-sixth Street. At this point deliveries stop and the wagon proceeds to the store, there to deposit the money collected on C. O. D. packages and to return undelivered goods. By this time it is usually after 12 o'clock, and the wagon goes to the stable to change horses and prepare for its second trip. The horse used on the morning trip is sent to its stall and a fresh one is harnessed to the wagon. The wagon starts out again at 1 o'clock to load up for another delivery. The same procedure as before is carried out, the wagon usually returning to the stable a few minutes before 5 o'clock. The horse used during the morning trip is harnessed to the wagon again and starts out on the 5 o'clock delivery. This horse returns about 7:30 or 8 o'clock. Hence we see that it takes two horses for every delivery wagon, the horse that makes only one trip on any one day making two trips on the following day, on a route calling for three deliveries each day. On a route having two deliveries a day, each horse makes but one trip a day.

It has been found that the mileage per wagon per day is nearly a constant, irrespective of the number of trips made. The method pursued which led up to this conclusion was the following: An odometer was placed on the axle of a delivery wagon in the service of one of the large department stores in the city. This wagon was sent over each of the routes specified in Table I., an accurate record being kept of the number of miles covered by the wagon on each day. This wagon was kept on the various routes in regular delivery service for a period of some three weeks, and the results obtained indicate that approximately the same number of miles are covered by all the wagons in this service each day. This will be readily understood when one considers that a wagon, making a trip over an apparently short route, is in reality covering very much more ground than would at first be thought. The density of population in the district which the route covers materially affects the number of deliveries and, consequently, the mileage of the wagon. The explanation of the fact that the average mileage per day of the wagons is nearly the same, is that experience extending over many years of service has taught those in charge the best method of district subdivision which will produce such a proportioning of the work that it shall be equally distributed among the units.

In determining the amount of work done per day by one of these delivery horses, it is essential to know the number of miles traveled by the horse, the average draw-bar pull of the wagon, and the average speed of the horse while in motion. To determine these factors one of the authors spent a number of days on his wheel following delivery wagons of many firms, under varying conditions of load and in many different streets. Attached to the wheel ridden was an accurately tested cyclometer and an equally accurately tested tachometer. A note book, pencil, and watch completed the outfit, and the following is an illustration of the method pursued in determining the amount of work done by horses attached to delivery wagons in New York city.

The draw-bar pull of the wagon was determined by the use of a traction dynamometer. For the wagons under consideration, it was found that the average pull per ton was 60 pounds on ordinary cobblestones at a speed of seven miles per hour. On asphalt the draw-bar pull was found to be 40 pounds per ton at seven miles per hour. The unit under consideration was composed of a wagon weighing 1,300 pounds drawn by a horse weighing 1,100 pounds. Each wagon is provided with a driver and a delivery boy. The average weight of the driver may be taken at 150 pounds and that of the boy at 125 pounds. Hence the total weight of the unit without load was 2,675 pounds. To this must be added the average load, which may be considered as being 500 pounds. Adding this to 2,675 pounds, we have as the total weight of the unit 3,175 pounds. The weight causing the draw-bar pull, however, is 2,075 pounds. The test recorded below was approximately one-half on cobblestones, and one-half on asphalt. The true average draw-bar pull may then be taken as having been 50 pounds per ton during the test.

The results may be considered as showing relatively the average amount of work done by a horse during about 4½ hours in harness in delivery service.

From the ascertained data we find that, starting from the store, the average speed while in motion was 6·7 miles per hour. The actual running time was 1 hour 36 minutes; time at rest, 2 hours 28 minutes.

From the time the horse left the stable until he returned to it was 4 hours and 52 minutes. The time taken to load at store was 46 minutes. The time to run from stable to store was 2 minutes. Hence the actual time the horse was working from the time he left the stable until he returned to it was 1 hour and 38 minutes; time at rest, 3 hours and 14 minutes.

It will be noticed that the horse was at rest and doing no work for nearly two-thirds of the time.

Taking the draw-bar pull, as found, at 50 pounds per ton, the number of foot pounds of work done by the horse in traveling 11 miles was $50 \times 58,080 = 2,904,000$ foot pounds, or at the rate of 1,781,596 foot pounds per hour, which is at the rate of 29,693 foot pounds per minute. This delivery horse then exerted nearly 0·9 of a theoretical horse power for 1 hour and 38 minutes. This was all the work done by this particular horse on this day. The following day this same horse made two trips over the same ground. From this data the average work done per day the year round by a horse in this class of service may be taken to be not over 16·5 miles at 50 pounds per ton, at a speed of 7 miles per hour. Other data bears out this conclusion. It is quite probable that on some special occasion a horse may be called upon to do more than is shown above, but the average work, day by day, for the year is not more than this. In fact, experience has shown that a horse in delivery service in New York city cannot average over fifteen miles a day for six days a week and be expected to render good service for any reasonable length of time.

The length of the working life of a horse in this service is seldom over five years. At the end of this time he has depreciated in value at least 50 per cent. and cannot be sold for more than half his original cost.

The time that a horse is in harness per day the year round will not average more than seven hours, and we have seen that he is only working a small fraction of this time. However, for the purposes of this paper, it will be considered that a horse can do a greater amount of work, day in and day out the year round, than experience has indicated that he accomplishes.

We will assume, therefore, that it is possible for a horse to do 21 miles a day under a draw-bar pull of 50 pounds, at 7 miles per hour, and be in harness eight hours a working day the year round.

The number of foot-pounds of work done per day by a horse, under this supposition, would be 5,280,000. This is at the rate of 29,333 foot-pounds per minute, or the horse is working at the rate of 0·89 of a theoretical horse power for three hours per day. This, of course, refers only to the time in actual motion.

Having established the amount of work that a horse is to do per day, it is now necessary to ascertain how much it costs to do this work. The basis upon which this calculation can most readily be made, for comparison with other values, is the ton-mile; that is, how much it costs to transport a ton one mile over a level road under ordinary conditions, the ton weight to include everything that enters as a factor in causing the draw-bar pull of the wagon. These factors are the weight of the wagon, weight of driver and boy, and weight of load carried. In order to facilitate the calculation, the data collected has been condensed into a table and is given below. This table represents the results of a personal canvass of a large number of stables for delivery and for general livery service. The figures given are the lowest that were procurable in New York city.

TABLE III.

Table of Items Entering into the Calculation of the Cost of Moving a Ton a Distance of a Mile on Level Ground, in Light Delivery Service in New York City.

	Cents.
1. Cost of food per day for one horse.....	32·00
2. Interest on cost of wagon (at 6 per cent. per annum) per day, original cost of wagon, $312.....	5·13
3. Interest on cost of horse (at 6 per cent. per annum) per day, original cost of horse, $125.....	2·06
4. Interest on cost of harness (at 6 per cent. per annum) per day, original cost of harness, $55.....	0·90
5. Part of stable rent charged to each horse per day..... (Cost of stable, $40,000. Int. at 6 per cent. = $2,400.) 48 horses in stable, part of rent chargeable to horses = $1,578.55.	9·39
6. Part of stable rent chargeable to each wagon per day, 24 wagons in stable..... Part of rent chargeable to wagons = $822.85.	9·39
7. Part of cost of attendance chargeable to each horse..... 4 men to take charge of 48 horses at $11 a week per man—$44 a week for care of horses.	13·66
8. Shoeing per horse per day ($3 per month a head, the year round)..	6·60
9. Driver per wagon per day, $12 per week.....	171·42
10. Boy helper, $8 per week.....	114·28
Total cost of 1 wagon, 1 horse and attendance per day.....	354·83

It is to be understood that this table represents the actual cost per day, to a stable in the city, for a wagon and horse, the figures given being those of a stable connected with one of the large dry goods houses in the city.

Assuming 500 pounds as the average load carried by any one wagon per day, the total weight of the unit which causes the drawbar pull as found before, is—

	Pounds.
Wagon.....	1,300
Driver.....	150
Boy.....	125
Load.....	500
Total.....	2,075

Hence, drawbar pull being taken as 50 pounds, the cost to move 1 ton 21 miles may be taken as 364·83 cents, the cost per ton-mile being then 17·373 cents.

Taking another case, where the two horses and the delivery wagon are considered, and assuming the most ideal conditions, we find the following:

TABLE IV.

Supposition:

One wagon making three deliveries a day of 800 lb. each, assuming 500 lb. average load as before, making a total delivery per day 2,400 lb.

To do this will require 2 horses, 1 wagon, 1 driver and 1 boy. The cost per day of this outfit from Table III. is as follows:

1.	Food for 2 horses.....	64
2.	Interest on cost of 2 horses.....	4 12
3.	Interest on cost of wagon.....	5 13
4.	Interest on cost of 1 set of harness..	9
5.	Stable rent chargeable to 2 horses..	18 78
6.	Stable rent chargeable to wagon....	9 39
7.	Attendance on 2 horses.....	27 32
8.	Shoeing 2 horses.....	13 20
9.	Driver.....	171 42
10.	Boy.....	114 28
	Total.....	428 54

The cost of delivery per pound is then 0·17856 cent. If we assume that in doing this work the wagon was out 12 hours and is in motion one-half its time, going at a speed of 7 miles per hour while in motion, then the wagon will cover 42 miles per day. Under these conditions the cost per ton mile is 10·2 cents. This is also the cost per car mile.

If we consider the load only, it costs 10·2 cents per 500 lb. per mile, or at the rate of 0·0204 cent per lb. per mile.

If we assume that on the three trips the deliveries average 50 per trip, then 150 deliveries were made per day. This is at the rate of 25 deliveries an hour or 1 delivery in 2·4 minutes. It is well to call attention here to the fact that a wagon sometimes is called upon to make as high as 100 to 150 deliveries on a single trip, and the average rate of delivery may be taken as not over 25 deliveries an hour. Hence it is evident that the case considered in Table IV. is for ideal conditions only. The weight per package under our supposition is 16 lb. and it is not often that the packages will average over 10 lb.

The results deduced from Table IV., it will be understood, represent the lowest possible figure under the conditions now existing in the stable under consideration. Therefore, if, in making a comparison between the costs of operating a horse and an electric delivery service under identical conditions, the above figures are used, all possibility of error in favor of the electric automobile would seem to be eliminated.

SECTION II.

SOME TESTS ON ELECTRIC AUTOMOBILES FOR DELIVERY SERVICE.

The results recorded in this section were obtained under service conditions, in the streets of New York city. Over 60 miles were covered during the tests recorded below, and all grades between the lower section of the city and Washington Heights were surmounted with the greatest ease. During the tests, various conditions of weather were encountered, including heavy rain, strong head winds, and muddy streets, as well as very clear weather, no wind, and dry streets.

During the series of tests, no accidents of any kind happened. It was not necessary at any time to stop the vehicles for repairs—all the mechanical and electrical parts performing their functions with the utmost ease, and with practically no noise, and absolutely no odor.

The method followed during all the tests was the same. It consisted in measuring the watt hours of energy supplied by the storage batteries during the runs, by means of a Thomson recording watt hour meter, which was accurately calibrated before the test began. The distance traveled by the vehicles was recorded by a tested cyclometer and the speed in miles per hour was noted at any second by means of a tachometer. Placed in series with the watt hour meter was a Weston portable ammeter, while a Weston voltmeter was placed across the battery connection at the controller. In this way, instantaneous readings of the power were obtained, while the watt hour meter gave the total energy used. The Weston instruments were accurate, and every precaution was taken to guard them from any jolts or jars which might have impaired their accuracy.

The first tests to be presented were made upon a vehicle built for a large dry goods store in New York city. The vehicle was intended for the delivery of light goods about the city, and was to be placed in competition with horse delivery service of the same class. The tabulated results show the instantaneous power consumption with this vehicle, while traveling over the same ground at the same speed as recorded on two different days.

An inspection of the data brings us to the conclusion that the power consumption is not greatly affected by change of pavement, as from cobble stones to asphalt. There is, however, a slightly greater power required on wet macadam than on dry, and more power is required on macadam than on asphalt or cobbles. The grades were measured in every case after the tests were completed.

A study of the data obtained during a test run of a little over 13 miles, in very bad weather, shows us that on grades the speed of the vehicle is very much reduced and that the power required to propel the vehicle at the reduced speed is very large—which is quite natural. The table is instructive in showing the relative proportion of increase of power due to grades. It

must be remembered, however, that the comparison is made in this case between level asphalted streets and macadamized hills that were very muddy, and that this condition would cause the variation in power to be greater than in the case of grades of asphalt surface. The average of ten readings taken on this trip gives as the power consumed on level asphalt the following:

Volts	85·3
Amperes	23·1

It is to be understood that these ten readings were selected from the table with the idea of eliminating up or down grades. The lowest ammeter reading taken was 20, and the highest 26. Above and below these readings the vehicle was on perceptibly up or down grades. It may be well to note that this wagon was equipped with solid rubber tires; these, as is quite generally recognized, absorb slightly less power than pneumatic tires.

The watt-hour-meter reading during a test in very fine weather of 6·25 miles, over a continually ascending route, showed a consumption of 1364·22 watt hours. The wagon alone was weighed on balanced coal-scales and was found to weigh 3,750 pounds. On this trip it carried three passengers and the instruments used. The total weight was found to be as follows:

Weight of wagon	3,750 lb.
" " passengers	413 "
" " instruments	37 "
Total weight	4,200 "

The distance traveled was 6·25 miles and the time actually in motion was 52·75 minutes.

Therefore:

Average speed in miles per hour was	8·44 miles.
The watt-hours per car mile were	218·28
The watt-hours per ton mile were	103·95

It should be remembered that these results were obtained during a run which was always tending uphill as was noted above. This becomes quite evident when the average of the 27 readings of this test is compared with the average of 10 readings taken during the test preceding it, representing level asphalt.

Average of the 27 readings:

Volts	84·72
Amperes	26·25

Average of the 10 readings:

Volts	85·3
Amperes	23·1

The record of a run down-hill in the reverse direction over the same course as the last showed a consumption of energy of 1243·38 watt-hours. The weight was the same as previously given, namely 4,200 pounds. The time in actual motion was 58·5 minutes. The distance traveled was 7·24 miles. The average speed per hour, 8·08 miles.

The watt-hours per car mile were	171·74
The watt-hours per ton mile were	81·08

Combining the results of the wattmeter readings for the tests in both directions, we find that for a total distance of 13·49 miles the average was as follows:

Watt hours per car mile	195·01
Watt hours per ton mile	92·875

The results were obtained under the ordinary service conditions and can be duplicated at any time.

To determine as accurately as possible the lowest value for the power consumption at the different speeds, some special tests were made. A block paved with asphalt which was fairly level between Twenty-fourth and Twenty-fifth Streets, on Madison Avenue, was selected for the tests. The method of procedure was as follows: First, readings were taken while the vehicle was passing between Twenty-fourth and Twenty-fifth Streets, and then readings were taken when passing back over the same ground, in every case care being taken that the vehicle had reached a constant speed an appreciable time before the readings were noted. The average of these readings should, of course, eliminate any slight grades, if present, and the average should give the true power consumption for absolutely level asphalt. The readings obtained for the three different speeds of the wagon were:

	Volts.	Amperes.
No. 3 speed—10·5 miles per hour	82	22
	82	20
Average	82	21
No. 2 speed—5·4 miles per hour	42	21
	42	18
Average	42	19·5
No. 1 speed—2 miles per hour	21	22
	21	16
Average	21	19

At No. 3 speed the rate of travel was 15·4 feet per second and the rate of work 1,722 watts. Since a watt represents 0·7373 foot pound per second, the total work required to propel the vehicle at this speed for one second was 1269·63 foot pounds. This represents a rate of 2·3 horse power. The draw-bar pull was then 52·44 pounds or at the rate of 39·26 pounds per ton. At No. 2 speed the drawbar pull was 36·3 pounds per ton. The value of the drawbar pull at No. 3 speed is probably very closely approximate to the value that would be shown at all speeds between 5 and 12 miles per hour if a dynamometer was used. From the data already given it is evident that we may take 105 watt hours per ton mile as quite within the reach of actual practice under service conditions to-day. However, a more conservative estimate of 120 watt hours per ton mile as a basis upon which to calculate the operating costs of electric vehicles for delivery service will be assumed. Under ordinary conditions a well designed electric delivery wagon should not consume over 120 watt hours per ton mile. In support of this statement the following data is presented, these results being obtained while testing a small carriage which, owing to a number of circumstances, had failed to come up to the expectations of the designers. This carriage had been sent back to the shop for some alterations, and it was at that time that an opportunity was afforded for making a number of experiments and tests upon it. The point of greatest interest in these tests is the fact that though working under most unfavorable conditions, the watt hours per ton mile did not reach 120. The weight of this vehicle was 1,200 pounds, over 300 pounds more than the original design called for. With one passenger and the instruments it weighed 1,400 pounds. Its drawbar pull was found, by a dynamometer, to be over 42 pounds at 8 miles per hour on level asphalt. This is at the rate of 62 pounds per ton, and is approximately the same as found for ordinary horse delivery wagons on cobble stones. This excessive drawbar pull was due to poor bearing design. Table IX. gives the result of a run of 9·45 miles with this vehicle on New York city streets.

TABLE IX.

Distance traveled	9·45 miles.
Watt hour meter record	771·15 watt hours.
Average speed	8·0 miles per hour.
Watt hours per ton mile	116·5

It is interesting to note that even with this abnormal pull the watt hours per ton mile were only 116·5.

The test recorded in Table X. was a fairly severe one so far as hill climbing and bad roads are concerned. The vehicle on this occasion traveled from Fifty-ninth Street up the Boulevard to One Hundred and Thirty-seventh Street and return, taking en route the long hill from One Hundred and Twenty-fifth Street to One Hundred and Thirty-seventh Street on the Boulevard; on the return the hill from One Hundred and Twenty-fifth Street to One Hundred and Seventeenth Street was surmounted. The hill climbing part of the trip was over a very bad macadam road surface. The hill at Ninety-sixth Street and the Boulevard was surmounted twice during the trip, and the carriage covered 14 miles.

TABLE X.

Distance traveled	14	miles.
Time in actual motion	1	hour 47 minutes.
Average speed	7·8	miles per hour.
Total watt hours recorded	1,162·29	
Watt hours per ton mile	118·57	

It is worthy of note that with all the hill climbing, the bad roads, and the large friction loss due to bad design, the watt-hours per ton mile only reached 118·57. From the above, 120 watt-hours per ton mile would seem to be a conservative estimate for the power consumption of well designed electric delivery wagons in New York city under ordinary service conditions.

SECTION III.

HORSE VERSUS ELECTRIC DELIVERY SERVICE — A COMPARISON.

In considering the advantages and disadvantages of two radically different systems for the performance of the same work, other things being equal, the cost is the deciding factor. Assuming that all other considerations are equal, it will be shown in this section that the cost of operation, maintenance, [etc., of the electric automobile is less than for horses in the light delivery service of New York city, the horse being considered in the most favorable light.

From the results recorded in Section II. we are led to the conclusion that, under highly disadvantageous conditions, the power necessary to propel a vehicle through the streets of New York city from the lower part of the town to points situated on the highest ground, including all grades that may be encountered, will not average more than 120 watt-hours per ton mile. That this is a high figure for vehicles of good design and equipment is evident from the results obtained while testing the delivery wagon previously mentioned. The fact that the small carriage never reached 120 watt-hours per ton mile, though working under most unfavorable conditions, should lend weight to this conclusion.

Taking 120 watt-hours per ton mile as a basis on which to compute the power consumed by an electric delivery wagon, we will now compare the results obtained in Section I., Table IV., with the results that would be obtained if an electric wagon were substituted.

From Table IV. it was found that the total cost per day for 2 horses, 1 driver and 1 boy, was 428·54c. The wagon was to travel 42 miles a day—being an average of 21 miles per day for each horse. The time in motion was assumed to be 6 hours. An electric wagon with an average speed of 9 miles an hour could cover this distance in 4·66 hours, thus saving 1·34 hours—the other conditions remaining the same. The cost per day for the electric, assuming cost of power at 5c. per k. w. hour, is given in Table XIII.

TABLE XIII.

		Cents.
1.	Cost of power for 42 mile run, at 5c. per k. w. hour. Assuming power consumption as 120 watt-hours per ton mile.	71·28
	Weight of wagon	3,750 lb.
	" " driver	150 "
	" " boy	125 "
	Average load	500 "
	Total weight	4,525 "
		2 263 tons.
	Watt-hours per car mile, 271·56	
	" " 42 car miles, 11,405·00 = 11,405 k. w. hours.	
	Taking battery efficiency as 80 per cent.	
	Total power to be paid for = 14·256 k. w. hours.	
2.	Interest on cost of wagon per day	21·4
	Cost of wagon, $2,300, at 6 per cent. interest.	
3.	Interest on stable rent for one wagon	9·39
4.	Driver	171·42
5.	Boy	114·28
	Total cost per day for 42 miles, 1 wagon, 1 driver, and 1 boy	387·77

Therefore, cost per pound of delivery is 0·16158c., or 0·01698c. less than the figures for the horse. The cost per car mile is 9·232c., or 0·968c. less than for the horse. Cost per ton mile is 4·08c., or 6·12c. less than for the horse service. If we consider the load only, it costs 9·232c. per 500 pounds per mile, or at the rate of 0·018464c. per lb. per mile, or 0·00194c. less per pound than for the horse service.

Attention is again called to the conditions under which this comparison is made. The horse is supposed to be able to average 21 miles per day, doing this at the rate of 7 miles per hour, under a drawbar pull of 50 pounds. In other words, he is doing work at the rate of 0·89 of a theoretical horse power for three hours per day. The automobile, on the other hand, is to do 42 miles a day at the rate of 9 miles per hour, and the cost of power is assumed to be 5c. per k. w. hour. Under these conditions the automobile can do the work of two horses in 1·34 hours less time than they can do it, with a saving of 0·01698c. per pound of goods delivered, or at a saving of 40·752c. per day on a delivery of 2,400 pounds.

Now, having shown that it is cheaper to use an electric delivery wagon than the present horse delivery wagon—even when the supposition is made that the horse is doing much more work than he really is—it is proposed to make a comparison between the two systems under conditions which actually exist to-day. It was shown in Section I. that the delivery horse does not average 18 miles per day during the year. We will assume, however, that the horse does travel this distance per day. Each wagon will go 36 miles a day under this assumption; hence the total mileage of the wagon for the year will be 11,268 miles. This assumes that on Sundays the wagon does not go out. Then for 52 days a year, at least, the horses have to be fed without any work in return. This, of course, is a condition not met in electric automobile service.

The cost per day for the two horses, wagon, driver, etc., necessary to accomplish 36 miles a day was found from Table IV., Section I., to be 428·54 cents. The cost of covering 11,268 miles will then be $1,562.20. Here it must be remembered that 365 days have to be taken. The cost per car mile is then 13·86 cents.

When we come to consider the electric automobile for a year, covering 36 miles a day, its advantages are brought out very clearly. Since the vehicle, owing to the nature of its construction, does not consume any energy when not in motion, it follows that, during the periods of rest, while deliveries are being made and the wagon is being loaded, there is no more expense than that incidental to wear and tear. This, of course, is common in amount to all vehicles of the same class and may be considered the same in each case. That a slight loss does occur when the vehicle is at rest, due to local action, etc., in the batteries, is true, but this loss is considered when the efficiency of the battery is taken at 80 per cent. We may say, then, that the factor most important in determining the expense of operating an electric vehicle is the price that must be paid for the power. This is a very variable factor, indeed, and the price per kilowatt hour will determine in all cases the amount of saving that will be possible through the use of electric automobiles.

A stable taking power from a large central station would, if of average size, add a load which, if properly distributed, as it easily could be, might become a considerable factor in straightening out the load curve of the station. If several stations were supplied from the same central station, this load would become a great source of economy to the station, and power could be sold to them at a very low figure. Owing to the regular nature of the work imposed upon the wagons in delivery service, it could easily be arranged to have the electric vehicles charged at night after the heavy load is off the station. They might also charge early in the morning and at noon or at periods that experience would indicate were the most advantageous for the station, the time of deliveries being adjusted to suit the new conditions. In this way a stable should be able to buy power at from 1 to 2 cents per kilowatt hour. As this time has not yet arrived, we will install for our purposes a small isolated gas engine plant. A plant of this kind should be able to produce a kilowatt hour at the switchboard for 3 cents. Assume the cost for a kilowatt hour as 3 cents, the power consumed per ton mile as 120 watt-hours and the weight as 3,500 pounds for the wagon. Taking the average load as 500 pounds, weight of driver as 150 pounds, and that of the boy as 125, the total weight is 4,275 pounds. The cost for the electric vehicle to cover 11,268 miles is given in Table XIV.

TABLE XIV.

1.	Cost of power for 11,268 miles at 3 cents. A kilowatt hour and a consumption of 120 watt-hours per ton mile, total weight = 4·275 pounds, = 2,137 tons, watt-hours per car mile = 256·44 kilowatt hours per 11,268 miles = 3889·57, taking efficiency of battery at 80 per cent. kilowatt hours to be paid for = 3,621.	$108.35
2.	Interest on cost of wagon at 6 per cent. for year. Cost of wagon, $2,300.	78.05
3.	Interest on stable rent for 1 wagon, for year	34.28
4.	Driver	625.68
5.	Boy	416.83
	Total cost per year	$1,263 15

Then the

	Cents.
Cost per car mile	11·21
Cost per ton mile	5·246
Cost of power per mile	0·961
Cost of power per ton mile	0·45

Hence the saving, considering that the horse-drawn wagon does 36 miles a day 6 days a week, is 2·65 cents per car mile in favor of the electric vehicle, which means a saving of 95·4 cents per day per wagon.

Owing to the greater speed of the electric vehicle, it takes only 4 hours to travel 36 miles, as against 5·14 hours for the horse. This is a saving of 1·14 hours per day, or of 356 hours a year.

The figures given above speak for themselves, and would appear to be a most effective argument in favor of adopting the electric automobile for delivery service.

SECTION IV.

CONCLUSION.

In light delivery service in large cities, when a number of units are employed by individual firms, the adoption of the automobile would seem to be merely a question of time. For this kind of service it seems preeminently the best solution. It is cheaper to operate than horse service, and the mechanical problems have been so far solved as to make the vehicles commercially successful. Though, as stated before, it is not the intention to discuss depreciation, it may be noted that the comparison of the costs of operation as regards food, cost of power, etc., would show a saving in favor of the electric delivery wagon, in one year, of 20 per cent., which, under more favorable conditions as to the price of power, might easily be increased. Assuming, for the moment, that the depreciation in a year is 25 per cent. for the electric system, and, under the same service conditions, is only 10 per cent. for horse trac-

tion, we still have a saving of 5 per cent. in favor of the automobile. The advantages that will arise from the substitution of mechanical propulsion for horse traction on a large scale are so well known and understood that any extended consideration of the subject seems unnecessary. Among the many advantages, however, the following would seem to be the most important.

1. The hygienic condition of large cities will be improved, and the cost of street cleaning will be decreased.

2. The wear and tear on pavements and streets will be reduced, and the use of rubber tires will lessen the noise in the crowded streets.

3. The traffic in cities will not be as congested, owing to the saving in room now occupied by the horse. When we consider that there are approximately 200,000 horses used in New York city alone, and that a horse increases the length of a unit by 9 feet, it can be readily appreciated how great a saving will be effected. Taking the average width occupied by a horse and shafts as 2 feet, it is seen that 200,000 horses occupy about 3,600,000 square feet, or 82·6 acres of valuable street room.

4. When the use of automobiles has become more general, the cost of operation will be reduced. This is true for the reason that with an increased output of wagons, the price will decrease, and with the greater use of power, the cost of it for this purpose will diminish.

5. The danger of accident from runaways will be eliminated.

THE RESTIO FAMILY.

THIS is a group of sedge-like perennial plants, with tall, dry, rush-like stems, almost destitute of true leaves, and with flowers in spikelets, sometimes few in number, at other times very abundant. They are, like the cape heaths, almost exclusively confined to the extreme point of southwest Africa, and about an equal number is found in the corresponding part of Australia. Nevertheless, there is no species common to both countries, and there is plenty of matter for speculation as to how it has come about that these two regions, and practically none other, should be tenanted by these plants. Latterly, indeed, one species has been found in Natal, and one in the mountains of British East Africa, so that we look for further developments as the flora of these regions becomes better known. One outlier, and a very singular one, is a species which was discovered in Cochin-China by M. Godefroy Lebeuf; and another exists in Chile. With these exceptions the geographical distribution is limited as above stated.

Very few of them are in cultivation. Most of them are so uninviting that even our botanic gardens contain few of the species. Till lately, indeed, we knew of but one—the plant named erroneously Wildenovia teres, but which is more correctly called Restio subverticillatus. We have known the male plant of this for many years in the botanic gardens of Oxford, Edinburgh, and Kew. Its graceful habit and pendent plumes of fine needle-like foliage render it, unlike most of its fellows, very ornamental. While most of these plants are unattractive, there are some that are more ornamental even than the species just named; such are Leptocarpus paniculatus, the very numerous male spikelets of which are arranged in elegant panicles; Restio giganteus, and various species of Thamnochortus. Some of these have of late been introduced from the cape for the purposes of house or church decoration, for which they are especially suitable. The flowers of some of these have been sown in the vain hope that they would grow—we say vain hope, for the sower has not always recognized the fact that what he has sown are the male flowers! These plants are, in fact, dioecious; the male flowers are on one plant, the female on another.

To make matters worse for the unfortunate botanist, it so happens that the male plants are sometimes very different in appearance from the female plants, and it is by no means unlikely that those responsible for the naming of these plants have occasionally mismatched them, and considered as mates plants that really do not stand in that relation to each other. And this leads us to remark that although the species are dioecious, and, as it appears, the pollen from the male must be wafted by the wind to the stigmas of the female, for there is nothing to attract insects to the flowers, yet there is little or no evidence of hybridization among them.

The species are sometimes very difficult of recognition, yet when once the observer gets a grasp of them he will find comparatively little evidence of variation in them, and none of hybridization. This is, of course, a general statement, not of universal application, for some of the species show a considerable amount of variation.

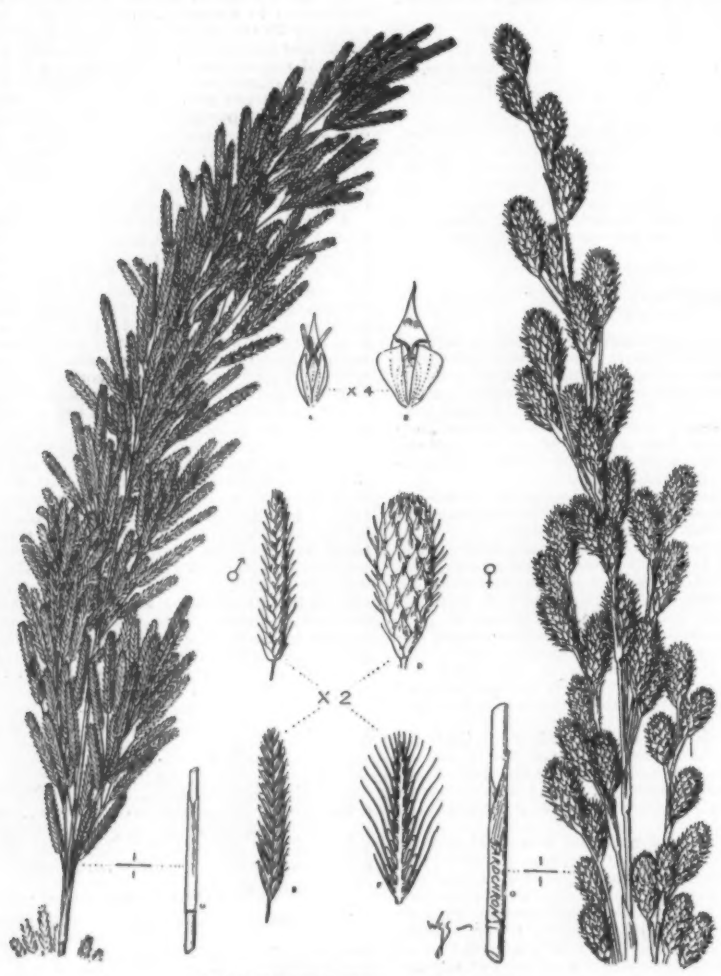
It is curious to see how well these plants are adapted to the conditions in which they grow, and how every effort seems to be made to economize energy, and avoid superfluous growth, and consequent exhaustion. Their tufted or creeping habit is adapted to the sandy soil in which they grow, while the almost entire absence or great reduction of the foliage obviates excess of transpiration, which in such a climate, and in such a dry soil, would speedily exhaust the plant. Male flowers are produced in abundance, but female flowers are not always, but usually, relatively scarce. Very often there is but one female flower to each spikelet, and it is rare for more than one seed to be perfected, so that the strain on the resources of the plant is reduced to a minimum; at the same time the chances of the perpetuation of the species are correspondingly diminished.

The seed vessel or fruit is capsular and dehiscent, or nut-like and indehiscent. In the former case, the solitary seed is hard and bony, but in the nut-like fruits it is the fruit that is hard and bony; while the covering of the seed is thin and membraneous.

These facts indicate that the plants are exposed to unpropitious climatal conditions, and that their structure and conformation are correspondingly adapted to enable them to maintain themselves in the struggle.

Circumstances seem to point to the conclusion that the Restiaceæ are an old family, once more widely spread than they are now, when they seem to be doomed to extinction at, geologically speaking, a not very remote period.

The two species of which we give figures are Thamnochortus spicigerus and Thamnochortus insignis, Mast., a hitherto undescribed species of striking appearance, and a stature of 3 or 4 feet. The illustrations give a sufficient idea of their general appearance.—We are indebted to The Gardeners' Chronicle for the above information.



THAMNOCHORTUS SPICIGERUS.

A, male flower from within; *B*, female flower from within; *C*, male spikelet; *D*, female spikelet; *E* and *F*, vertical sections through the spikelets; *G*, sheaths and stem. Color of flowers chestnut-brown.

THAMNOCHORTUS INSIGNIS, FEMALE PLANT.

A, spikelet; *B*, section through spikelet; *C*, bract and female flower; *D*, sheath. Color chestnut-brown.

The Cigar Bean of Batavia.—A very curious fruit has been discovered growing wild in Batavia, and a sample has been sent to a French professor of botany at Paris. It appears to be a species of bean resembling a cigar both in form and color, though only about an inch in length. But it has a peculiar characteristic which renders it a very unique and interesting object, and this is the exceedingly energetic manner in which it scatters its seeds. If one of these little fruits be thrown into a basin of water, it will rest quietly on the surface for from two to five minutes; then it will explode with violence, hurling most of its contents into the air with a noise and splash for all the world like a small torpedo. It is hardly necessary to say that this phenomenon is caused by the pressure of the elastic substance of its interior overcoming the resistance of its hard outer shell. The fruit usually splits open lengthwise. If plucked before maturity and allowed to ripen in a warm spot, it opens gradually from apex to base, making, as it were, a pair of diverging horns starting from the same point. If left to ripen on the plant—since the process is quicker and the internal moisture greater—the opening is sudden and accompanied with a slight noise, though this is much less than that which takes place when it has been placed in water. In this case the dry but porous tissue of the surface of the fruit quickly absorbs the liquid, especially at the grooves caused by the junction of the two valves or outer shells of the fruit. The internal tissue, being very elastic, exerts upon the latter a tension which soon results in the violent bursting already described. The curious property of explosion is given the little plant for the dissemination of its seeds, which would otherwise stand a poor chance of propagating its species.

The Waverley station of the North British Railway in Edinburgh, the largest railway station in the United Kingdom, will be finished this summer after undergoing reconstruction and enlargement for over five years. Enlargement became necessary in consequence of the great increase of traffic on the East coast and Midland routes, between Scotland and England, after the Forth Bridge was built. This also necessitates the doubling of the tunnels in the Princess valley to the east and west, and the quadrupling of the track for 3 miles on each of these sides of the city. The station now covers 23 acres of ground, of which 11¼ acres are under roof. The two largest stations in England that can be compared with it are the Liverpool Street station, London, which covers 22½ acres and has 6¼ acres under roof, and the New Street station, Birmingham, which covers 10¾ acres and has 8¾ acres under roof. The total length of platforms in the Waverley station is 3¾ miles. There are 8 main lines running through it, and there are 56 dock roads and sidings, which are worked from 4 signal cabins by 238 switches and 290 signals. The estimated cost of reconstruction, exclusive of land, will amount to £2,427,500.—Railway Review.

MAPPING THE MAMMOTH CAVE.

By Dr. HORACE C. HOVEY, F.G.S.A.

THE statement has been repeatedly made, on the authority of the State geologists of Kentucky, that there are 225 known rooms and avenues in the Mammoth Cave, whose combined length would exceed one hundred and fifty miles. This random estimate has put those at a disadvantage who have wished to learn the exact facts, while it has gratified the exhibitors of this greatest of all caverns. The owners have objected to the making or publishing of accurate interior or exterior surveys, lest other modes of entrance should be found besides what is now regarded as the only mouth. They have not objected to sketches as helpful to the ordinary tourist.

In 1882, the writer had the honor to read a paper on "Subterranean Map-Making," at the Montreal meeting of the American Association for the Advancement of Science, which was published in the Proceedings of that body. It was accompanied by maps of several American caverns, one of them being the best available map of the Mammoth Cave, together with some account of its production.

Mention was made of the first rude outline, five years after the discovery of the cavern, and published in 1814 in The Medical Repository, vol. xvii., p. 391. It was either drawn by Mr. Gratz, an early owner of the property, or for him by a Mr. Bogert. Two years later Dr. Nahum Ward published in The Worcester Spy a plan of the cave in order to locate the finding of certain mummies said to have been exhumed there. Neither of these could properly be called "a map," no use of chain or compass being made.

A more careful survey of the main cave and a few of its known branches was made by a civil engineer named Edmund F. Lee, in the winter of 1834–35, who is said to have given three months to his task.* It was published by James & Gazley, of Cincinnati, with notes. The only copy extant happens to be divided between Dr. Call and myself, he having the map and I the notes upon it in full. Lee's map contained serious errors after all, and in the writer's opinion it has had altogether too much importance given to it in its relation to better work done since it appeared and vanished.

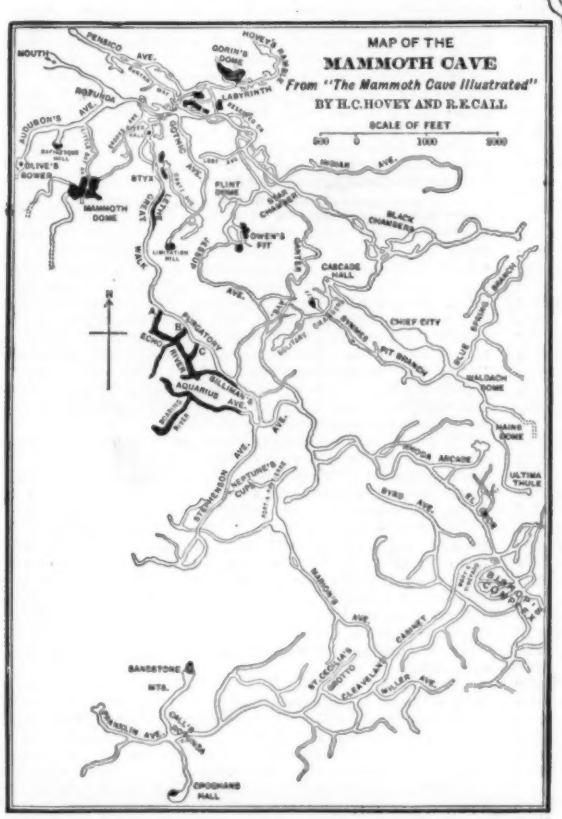
Stephen Bishop, the negro guide, discovered the region beyond the rivers, as well as other parts not previously explored. Though a slave, he had considerable learning; had some knowledge of the classics and natural sciences; and there is no reason for not giving him full credit for the elaborate map bearing his name as the author, and that was published in 1846 to accompany a volume styled "Rambles in Mammoth Cave, by a Visitor," from the press of Morton & Griswold, of Louisville, Ky. The book is out of print, and it is said, whether with truth or not we do not know, that the map was intentionally suppressed for prudential reasons. One of the few copies now extant is in the writer's library.

Next in order of time came the extensive surveys made by Dr. C. R. Blackall, of Philadelphia, during the summers of 1870 and 1871, both interiorly and exteriorly; surface measurements being by air-line, but those underground following the curves of passages. The bearings were taken by a standard compass, and the distances by line wherever practicable, and elsewhere by pacing carefully. The permission of the managers had been gained to make this survey, and it was the original intention to have the result go with a volume describing the cave and its contents, giving also accurate tables of distances, heights, and depths. Preliminary to this, however, Dr. Blackall undertook to give the first fruits of his work in the form of a familiar lecture in the hotel parlor. The apprehension of Judge Underwood, at that time the cave trustee, was excited, who so seriously objected to publication that the whole matter was dropped until now. My own share in the matter is mainly that of having finally induced the eminent author of this remarkable and valuable map to allow me to lay it before the public, as an offering to the scientific world. It should be added that Dr. Blackall is at the head of the editorial department of the American Baptist Publication Society, and is ready to explain or, if need be, to defend his map and its process of production. It is to be hoped that he may soon carry out his intention of publishing in full the methods of his subterranean explorations.

The Lippincott press, of Philadelphia, published in 1875 Forwood's manual of Mammoth Cave, an attractive volume, with a new map of the regular routes as taken in exhibiting the cave. The map must have been mainly made by guesswork, and is by no means trustworthy. Several other sketches have since been made by newspaper correspondents and others, which need not even be mentioned, except to say that they are worthless as maps.

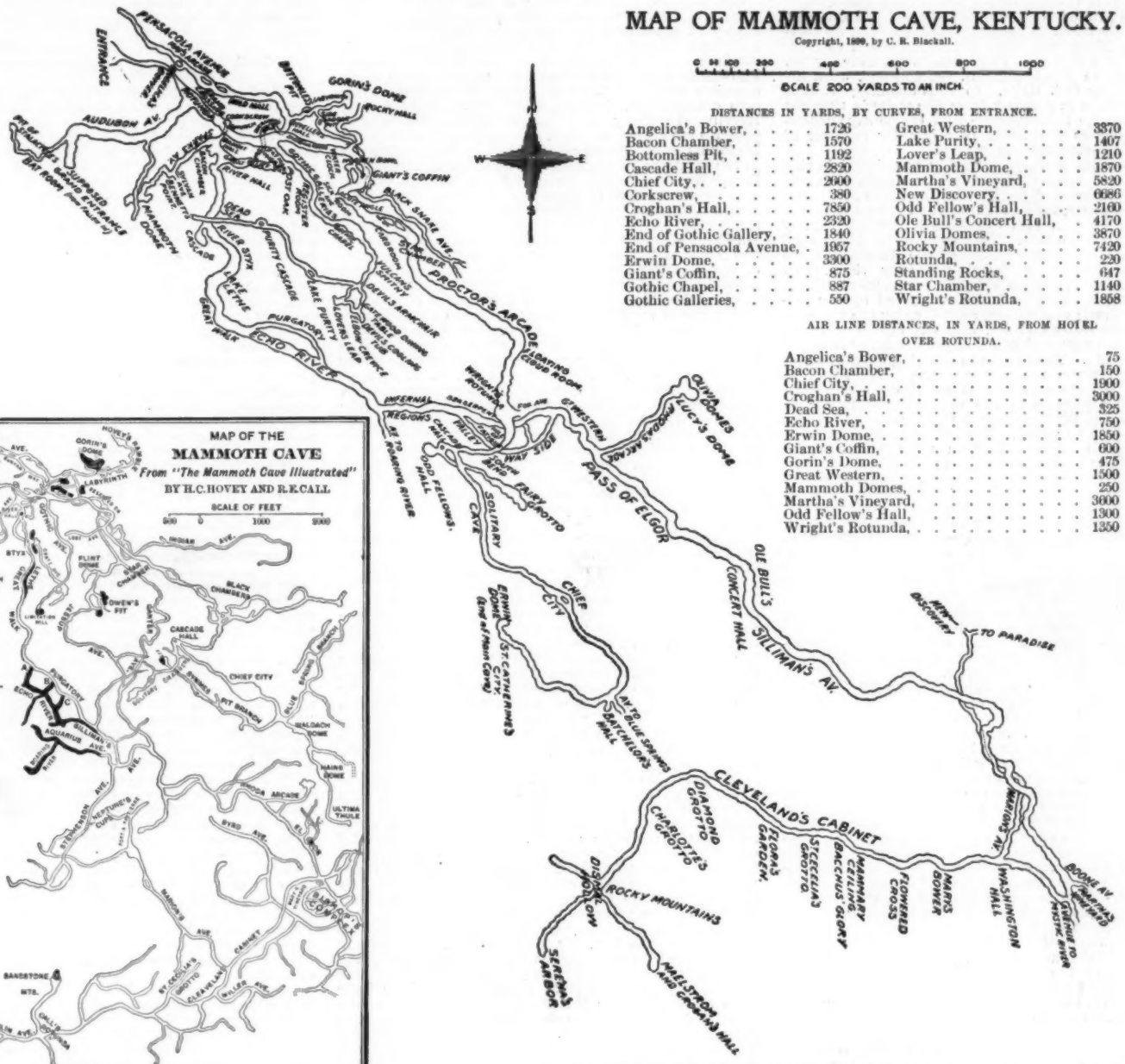
My own mapping of Mammoth Cave has been limited to certain localities, notably the long, winding passage known as Ganter Avenue, 8,500 feet long, together with the rectification of errors in former surveys. What is naturally enough known as "Hovey's map" was prepared under my supervision and for use in my work on "Celebrated American Caverns," and the successive editions of my guide-book, all from the press of the Robert Clarke Company, Cincinnati. It also accompanied my article on Mammoth Cave in the Encyclopedia Britannica, vol. xv., p. 449; is found in Dana's new Text-book of Geology (fourth edition, 1883), p. 103, and elsewhere.

In my paper on "Subterranean Map-Making," read before the A. A. A. S., after ample mention of what had been done by Lee, Bishop, and Blackall, it is stated that "all the portion open to the public, as far in as the Echo River, is drawn after the recent survey made by Col. Francis Klett, manager of the cave;" while concerning the portion beyond the rivers it is stated that "the details are filled in from older surveys." A similar statement is made in a foot note to my article in the Encyclopedia Britannica, mentioning particularly Bishop and Klett. The writer, indeed, claimed for himself less than he was entitled to in his anxiety to do justice to others. It may be added that Col. Klett was made manager by Capt. George M. Wheeler, U.S.A., when the latter was trustee of the estate, and he had for nine years before that been working with him for the United States Geographical Survey. When Capt. Wheeler's trusteeship ended, Klett's services were dispensed with, and he never accomplished all that he promised to do by way of a survey of the entire cavern; but he should get credit for what he did, especially seeing that he is now departed from this life. As I was with him during his partial survey, and made use of his material, I only affirm what I know to be true in saying that Klett re-



THE HOVEY AND CALL MAMMOTH CAVE MAP.

By permission of the American Book Company.



THE BLACKALL MAMMOTH CAVE MAP.

By permission of C. R. Blackall.

* Lee's map of the Mammoth Cave has been so often referred to as the finished work of an expert civil engineer, that it becomes necessary to break that illusion. In the notes that accompany his famous map he says: "I measured the Bottomless Pit; the depth was 173 feet—perhaps a hundred feet lower." "The deepest pit is in the Little Bat Room, about 280 feet deep, or 120 feet below Green River. The Bottomless Pit is also deeper than the bed of Green River, and I believe also the Covered Pit and some others."

Ben Hains found the depth of the Bottomless Pit but 94 feet 6 inches, while the deepest spot found by my own plummet was 105 feet. In the summer of 1896 Dr. Call and myself measured the depth of the Crevice Pit in the Little Bat Room, with the utmost care, and found that from its edge to the bottom it was 88 feet; or by adding to this the remaining depth of the floor of the Mammoth Dome, of which this pit is the upper opening, the total depth is exactly 119 feet, as against Lee's 280 feet.

Lee's theory that the accumulated waters of Mammoth Cave occupy a bed lower than Green River, and that they ultimately run by subterranean channels to the Ohio River, or possibly the Ocean, is proved to be utterly erroneous by barometric observations, which he, as an expert civil engineer, should have made before risking such a wild assertion. "Honor to whom honor is due;" but when a map-maker trips into such errors as the foregoing, he forfeits his standing as an authority to whom those that come after him must defer.—H. C. H.

surveyed the entire "Short Route," proving its courses to vary materially from the maps of Lee and Bishop.

In preparing the illustrated manual of Mammoth Cave that was brought out early in 1897 by the press of J. P. Morton & Company, of Louisville, as the joint work of H. C. Hovey and R. E. Call, it was felt that an improved map was required. Numerous discoveries had been made by various explorers since the publication of the older maps, and many errors needed to be corrected. In the division of labor, this task of redrafting the map was claimed by Dr. Call, but it was by no means intended by the present writer to renounce his share in it altogether. Much less can he allow to pass without a protest, even at this late hour, the remark by Dr. Call before the Indiana Academy of Science, and repeated in Speluncа, the official organ of the Société de Spéléologie (Paris), that Hovey's map "is chiefly that of Bishop, and follows closely the original work of Lee, though no mention is made of these sources." Such a slip of my comrade's usually careful pen does not tally with the facts. For, as previously stated, all the "short route" had been resurveyed under my supervision, and full credit for the rest was given to those to whom it was due. It is only fair to Dr. Call to presume that he would have conferred with me about this matter, had I not been abroad, cave-hunting in France, with MM. Martel and Viré, at the time of publication. Aside from this, however, no cartography of Mammoth Cave can be regarded as complete that fails to mention the great work done by Dr. Blackall, or the less important, yet genuine, work accomplished by Col. Klett. In thus claiming what is due to others, it is farthest from the writer's thought to disparage the indefatigable and eminently successful achievements of Dr. Call, or any other explorer of Kentucky's famous labyrinth.

The two maps most prominently mentioned in this article are laid before the reader for comparison. It must be remembered that each was made independently of the other; a fact making their points of agreement, or of difference, all the more interesting. They agree in general outline. They suggest the theory that the congeries of caverns known as the Mammoth Cave may be regarded as underlying a long ridge, from which branches reach out sidewise to surface openings. That such openings exist is demonstrated by the perfect atmospheric ventilation, as well as by the currents in the subterranean rivers, and the debris of forest leaves, nuts, twigs and other objects recently brought in from outside. They agree in differing from Bishop's old map on numerous minor points. For instance, Pensacola Avenue was located by Klett and myself north of and parallel to the beginning of the Main Cave; whereas Bishop made it run far south of it into proximity to River Hall. Blackall coincides with us instead of with Bishop. But, on the other hand, his plotting of the river region agrees with Bishop, instead of with Hovey and Call. Both maps depart widely from Bishop's in the location of Cleveland's Cabinet. I discovered long ago that Bishop had erred in swinging the end of the cave too far to the north, and wished to correct the error on my map, but was not allowed to do so by Manager Klett, lest the lines should run beyond the limits of the estate. In the recent standard map the end is pushed much further southward; and in Blackall's further yet—which is undoubtedly correct. Other divergencies and coincidences will be noted by any one familiar with the cavern topography. The names in use thirty years ago were intentionally retained by Dr. Blackall, whereas in our latest map the names at present in use are given.

Blackall's map is drawn to the scale of 200 yards to the inch, which he assures me is meant to be exactly correct. Many important exterior and interior measurements are indicated. The former have never previously been given; and the latter are just about one-half what is stated by the guides. The lines within the cave are run from the entrance following the curves of passages; those without are by "air line" from the hotel that stands directly over the Rotunda. The total length of what is termed the Main Cave is 3,300 yards, or less than two miles; said by the guides to be four. The air-line distance is 1,850 yards, or a little more than a mile from the hotel. The distance interiorly from the entrance to the end of the long route, at Croghan's Hall, is 7,850 yards, or about four and a half miles. This agrees with my measurement as made in 1882; and also with subsequent measurements made by Prof. Newton, of Yale University, and Dr. Foote, of Philadelphia, and others. The guides had previously called it ten miles.

The Standard Map, so called because adopted by the authorities, is in a sense composite, being the work of no one man, but embodying what has been successively done by Lee, Bishop, Klett, Hovey and Call, and finally redrawn on a reduced scale for the revised edition of Dana's Text-Book of Geology (1897), the original plate being kindly furnished for this article by the American Book Company, to whom due acknowledgment is hereby made for the favor. The same map substantially is found in the illustrated guide manual of Mammoth Cave, with the different routes indicated by shading, and all the noted localities numerically designated according to a key prepared by Dr. Call. For the most part it is drawn to a scale of about 2,000 feet to the inch. This does not apply throughout, however, as can be seen by applying it to Ganter Avenue, which is known to be 8,500 feet long, whereas on this map it seems only half that distance. There are five different galleries in the cavern, from one to another of which the pathway wanders, often by bridging or tunneling other courses, thus making it very difficult for the map-maker to mark these changes on a flat surface of paper. Some of the deepest parts are marked in black, especially where the excavation cuts down to the drainage level.

In conclusion we are ready to agree with critics who may say that after all no adequate and satisfactory map of the Mammoth Cave has yet been published. The only claim for these two maps is that they are the best extant. We wish that men of science, and all who are on any account interested in underground America, would unite in an appeal to the owners of this marvelous cavern to dimiss their apprehensions of harm from rival interests, and after taking due legal measures to protect their rights, to encourage and aid in every way the most complete and accurate interior and exterior survey that can be made by expert cartographers.

The Mammoth Cave estate belongs to the immediate heirs of the late Dr. John Croghan, his nephews and nieces, of whom only three survive, all being over eighty years of age. By his will, a copy of which is in our possession, the estate must be sold at auction to the highest bidder after the death of the last survivor, and the avails divided equally among the heirs of the original legatees. Wishing length of days to the present owners, we would suggest and urge that, whenever the day of sale shall arrive, the State of Kentucky should become the purchaser, and should include the group of neighboring caverns and grottoes, of which there are ten or more, in a public domain, to be styled "The Mammoth Cave Park," whose mazes and mysteries should be fully and scientifically explored and made known to the world.

[Continued from SUPPLEMENT, No. 1228, page 19685.]

PROGRESS IN THE IRON AND STEEL INDUSTRIES.*

ATTENTION must now be directed to the great process for the production of steel which involved the use of the "open hearth."

Sir William Siemens' life was one long and ultimately brilliantly successful effort to apply the kinetic theory of gases and the dynamical theory of heat to industrial practice. He was eminently a practical worker; but the depth and accuracy of his scientific knowledge gives him a place near that of all the great atomists from the time of Lucretius to that of our own countrymen, Graham, Joule, Clerk Maxwell, and Kelvin. In many of Siemens' papers, theory and practice are closely blended. In viewing the results of his labors, it will be seen in future ages that confidence in the trustworthy character of steel was finally established by experiments on metal produced in the regenerative furnace of Siemens. Looking back, it is astonishing with what difficulties the use of steel for structural purposes was beset. In 1859 Sir John Hawkshaw was not permitted by the regulations of the Board of Trade to employ steel in the construction of the Charing Cross bridge. Time will not permit me to indicate the efforts which were made to induce the Board of Trade to remove the serious hindrances to the use of steel which had "rendered the construction of the projected bridge over the Firth of Forth practically impossible." These efforts were not successful until 1877, when a committee, consisting of Sir John Hawkshaw, Col. Yolland, and Mr. W. H. Barlow, were able to recommend that the employment of steel in engineering structures should be authorized by the Board of Trade. The steel employed was to be "cast steel, or steel made by some process of fusion, subsequently rolled or hammered;" one condition of such recommendation being that "the greatest load which can be brought upon the bridge or structure, added to the weight of the superstructure, should not produce a greater strain in any part than 6½ tons per square inch."

As regards the use of steel for shipbuilding purposes, in the year 1875 Sir Nathaniel Barnaby asked, "What are our prospects of obtaining a material which we can use without such delicate manipulation and so much fear and trembling?" He partly answered his own question four years later, when he quoted experimental evidence as to "the recent successes" of open-hearth steel. In 1890 he completed the case by pointing out that naval architects now "have a perfectly regular material, stronger and more ductile" than iron, and he speaks of "our lasting debt of gratitude for the birth and training of that true prince, William Siemens." It is hardly necessary to point out that the country owes the excellent materials used in naval architecture mainly to the productions of the regenerative furnace.

In connection with the production of mild steel, the addition of ferro-manganese to the decarburized bath proved to be most effective. We can hardly overestimate our indebtedness to those whose perseverance insured the adoption of mild steel for maritime and other purposes. "Looked at from the standpoint of to-day, when thousands of tons of such steel are made weekly without serious anxiety or trouble, it is scarcely possible to realize the anxieties and difficulties of the days when the manufacture of open-hearth steel was being perfected." To no one is our debt greater than to our vice-president, Mr. James Riley, who bore a large share of the anxieties of the early days, and whose words are those I have just quoted.

With regard to the great modifications which have been effected in the Bessemer and open hearth processes, reference must be made to that ample source of information, our journal. It must also be consulted for the history of the appliances for heating the blast, with which the names of Cowper and of Whitwell will always be specially connected.

In speaking of Bessemer and Siemens, I have been obliged to depart somewhat from strict chronological order. I must now resume it.

In the year 1866 Graham's first paper on the occlusion of gases by metals was published in the Philosophical Transactions. Its results have been far reaching, and will always be ranged with the metallurgical triumphs of the century.

In the year 1869 our institute was founded. In view of certain aspects of the treatment which inventors had previously received from their industrial brethren and from the country, it will be evident that the time for its formation had fully come. Taking instances almost at random, I may remind you that Dud Dudley was, as he says, "with lawsuits and riots wearied and disabled" in the seventeenth century, and that Henry Cort was neglected and oppressed in the eighteenth. The great invention of iron bottoms in the puddling furnace made by Rogers was received with ridicule, and he died in poverty. Popular tradition of Sheffield indicates that possession was obtained of Huntsman's secret "by the heartless trick of a rival." Neilson, though he warmly acknowledges the support he received from certain iron masters, was treated with singular meanness by others. Heath fought single handed for fifteen years "against a common purse, the accumulation of the wealth which he had created." Even Bessemer's early statements were received with incredulity and contempt. With the formation of our institute all this is changed; men place the results of their work and experience freely at the disposal of their brethren, and each fresh advance meets with appreciative consideration. "Vigorous moderateness," wrote the late Walter Bagehot, "is the rule of a polity which works by discussion. . . . It was government by discussion that broke the bond of ages and set free the originality of mankind."

[It was then pointed out that the history of the iron and steel industry since the formation of this institute was epitomized by the labors of those who had occupied the presidential chair. The president, therefore, gave a brief sketch of the work done either by the successive presidents of the institute, or during their respective terms of office.]

The address then continues as follows: This concludes the list of those who have hitherto presided over the institute, and it will have been evident that from time to time other interests than those connected with iron and steel have been represented by your presidents. We were reminded of this fact when the institute first met, now twenty-four years ago, at Manchester, where we are promised a delightful meeting again next autumn. The bishop of that great city then welcomed us by a quotation from Virgil, which connects the age of iron with the age of gold. The passage runs thus:

"Quo ferrea primum
Desinet ac toto surget gens aurea mundo."

A president of this institute who has had the privilege to serve in the mint, in a sense connects the iron and the golden age. I find that during the course of a long official career I have been responsible for the standard fineness of over one hundred and twenty-one millions of gold coin. This sum is so vast, and the anxiety connected with it has been at times so great, that I am not careful to conceal the pride revealed by this reference to it, as it is an exponent of the financial greatness of the nation which created the age of steel. But I value as highly the means of conducting research and the hope of being useful, which was also given me by the government when I was appointed Professor of Metallurgy at the Royal School of Mines. I have in the discharge of my duties persistently striven to show that what is called applied science is nothing but the application of pure science to particular classes of problems.

I regret that space will not permit me to consider the progress of the century as measured by the work of our Bessemer medalists. I hope, however, as regards the labors of the foreign recipients of the honor, to deal with them next spring. The metallurgy of America is so closely interwoven with our own, that I must permit myself a brief reference to four men who stand out from the industrial ranks of our kinsmen. These are Alexander Lyman Holley, the Hon. Abram S. Hewitt, John Fritz, and Prof. Henry Marion Howe. All of them are Bessemer medalists.

It may help us to estimate the value of the labors of the four men whose names I have given if we remember that at the present time the United States export about a million tons of iron and steel a year, while twenty years ago they were not exporting any. We may also fairly consider their influence on the rapid development of the United States navy. It would seem that we, in this country, in the belief in our insular security, had somewhat neglected the art of naval warfare, until Admiral Mahan reminded us of what we had done in the past, and of our possible course in the future, in a series of writings which have done much to convince the two nations, England and America, "that they are in many ways one."

It is time to offer a collective statement of the achievements which have either been actually effected or are in immediate prospect.

There are blast furnaces which will produce 748 tons of pig iron in twenty-four hours, with a consumption of little over 15·4 cwts. of coke per ton of iron. The gases from blast furnaces are used, not only as sources of heat, but directly in gas engines.

There are Bessemer converters which can hold 50 tons of metal, and open hearth furnaces which will also take 50 tons, while 100-ton furnaces are projected. The open hearth furnaces are fed with one ton of material in a minute, by the aid of a large spoon worked by an electro motor. There are gigantic "mixers," capable of holding 200 tons of pig iron, in which, moreover, a certain amount of preliminary purification is effected.

Steel plates are rolled of over 300 feet in area and 3 inches thick. There are girders which justify the belief of Sir Benjamin Baker that a bridge connecting England and France could be built over the channel in half-mile spans. There are ship plates which buckle up during a collision, but remain water tight.

There are steel armor-piercing shot which will penetrate a thickness of steel equivalent to over 37 inches of wrought iron. The points of the shot remain intact, although the striking velocities are nearly 2,800 feet a second. There are wires which will sustain a load of 170 tons per square inch without fracture. Hadfield, whose labors will, I trust, be continued far into the twentieth century, has given us manganese steel that will not soften by annealing; while Guillaume has studied the properties of certain nickel steels that will not expand by heat, and others that contract when heated and expand when cool. Nickel, chromium, titanium, and tungsten are freely used alloyed with iron, and the use of vanadium, uranium, molybdenum, and even glucinium, is suggested. There are steel rails which will remain in use seventeen years, and only lose 5 pounds per yard, though fifty and a half million tons of traffic have passed over them.

Huge ingots are placed in soaking pits and forged direct by 120-ton hammers, or pressed into shape by 14,000-ton presses. With such machinery the name of our late Member of Council, Benjamin Walker, will always be connected.

There are steel castings, for parts of ships, that weigh over 35 tons. We electrically rivet and electrically anneal hardened ship plates that could not otherwise be drilled. Photomicrography, originated by Sorby in 1864, now enables us to study the pathology of steel, and to suggest remedial measures for its treatment. Stead's work in this field is already recognized as classical. Ewing and Rosenhain have, in a beautiful research, recognized quite recently by its aid that the

* Abstract of the presidential address to the Iron and Steel Institute, by Prof. Sir W. Roberts-Austen, K.C.B., D.C.L., F.R.S., delivered before the members of the Institute on May 4.—From Nature.

plasticity of a metal is due to "slip" along the cleavage planes of crystals. Osmond also by its aid shows that the entire structure of certain alloys may be changed by heating to so low a temperature as 225° C.

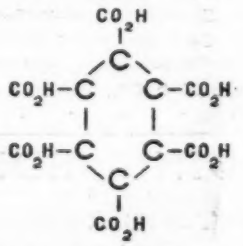
Passing to questions bearing upon molecular activity, we are still confronted with the marvel that a few tenths per cent. of carbon is the main factor in determining the properties of steel. We are, therefore, still repeating the question, "How does the carbon act?" which was raised by Bergman at the end of the eighteenth century. Nevertheless, from the molecular point of view, much may be said in answer to the question. The mystery is in fact lessened now, as it is known that the mode of existence of carbon in iron follows the laws of ordinary saline solutions. Our knowledge is, however, of very recent origin, and we owe mainly to the Alloys Research Committee of the Institution of Mechanical Engineers the development of Matthiessen's view that there is absolute parallelism of the solution of salt in water and carbon in iron.

An ice-floe in a polar sea contains a small percentage of salt; a red hot ingot of mild steel holds some two-tenths per cent. of carbon, but both the carbon and the salt are in the state of solid solution. If the ice had been cooled below —18° C., it would entangle a solidified portion of salt water, which was the last part of the mass to remain fluid. So in the steel ingot, when it has cooled to the ordinary temperature, there is a solidified "mother liquor" of carburized iron. We do not as yet know whether carbon is dissolved in fluid iron as carbon or as a carbide. We do know, however, that the presence of 0·5 per cent. of carbon in iron (such an amount as might occur in a steel rail) lowers the melting point of the iron from 1600° C. to 1530° C. This lowering has enabled a calculation to be made, the result of which shows that the number of atoms in a molecule of carbon in fluid iron at this temperature is probably two. It can be shown that at a temperature of 800° C. the number of atoms in the molecule of carbon dissolved in solid iron is, in all probability, three. At lower temperatures, the number of atoms is probably more than three. We metallurgists are not accustomed t think in atoms. Let me, therefore,

represent such a three-atom molecule thus,

without assuming how much iron is associated with the carbon. Following Bergman's experimental method, but with the interval of more than a century separating his work from ours, we investigate the action of acids on carburized iron with a view to ascertain the nature of the atomic grouping of the carbon.

In explaining this, I may adopt the appended figure. It is most difficult even to attempt to make questions of atomic grouping clear in a paragraph, but the figure will be helpful. To the historian it suggests vivid pages of Italian history, as the six spheres so arranged constitute the arms of the powerful family of Medici. To the chemist it is a precious symbol, and appeals to him as representing the carbon atoms as grouped in the benzene ring. The result of treating carburized iron with various acids is the formation of marsh gas and more complicated organic compounds, of which propylene, acetylene, ethylene, and naphtha may be mentioned. Does the nature of these products help us to ascertain the number of the atoms in the carbon molecule as it exists in cold steel? I have consulted organic chemists, among whom I would specially mention my colleague, Dr. Wynne, and their evidence is encouraging. The result of the action of powerful oxidizing agents on certain forms of carbon is mellitic acid, $C_6(CO_2H)_6$, which is one of the benzene series, and this favors the view that solid carbon contains twelve, or some multiple of twelve, atoms in the molecule. But mellitic acid is graphically represented in the annexed diagram, the carbon atoms being arranged as



the six spheres are in the arms of the Medici. The group CO_2H is tacked on to each carbon sphere. From this it may be argued that the molecule of solid carbon consists of one or more carbon "rings." In cold steel, the group of CO_2H may be replaced by the group Fe_2, which is broken off by the action of suitable solvents leaving free carbon. Hence the six-atom carbon molecule may exist in steel.

My object is merely to show you how far at the end of the century we have advanced in our knowledge of the mode of action of carbon, and I trust it will be evident that the progress is remarkable. We know that even in solid iron the carbon atom must push and thrust with great vigor, for we can measure the "osmotic pressure" the carbon atom exerts, and, as has just been shown, we can even picture the mode of the atomic grouping in the molecule.

I can only just sum up the evidence as to the occurrence of molecular change in iron. To Gore, and to Barrett, we owe the investigation of the nature of a fact which had long been well known to smiths, that iron on cooling from a bright red heat suddenly emits a glow. We now know that as steel cools down there may be at least six points at which molecular change occurs, accompanied by evolution of heat.

In a series of classical papers of which we are justly proud, for many of them have been communicated to this institute, our member, Osmond, has shown what is the significance of some of these points, and has won an enduring reputation. We measure and record them photographically as readily as if they were barometric variations. It is known that three points occur in the purest electro-iron yet prepared. Two points are connected with the magnetic permeability of iron. One point at least is due to the power iron has of dissolving carbon. In some cases two points occur far below a red heat, and appear to be due to the presence of hydrogen. Moreover, the molecular condition of steel cooled from an intense white heat is not the same as that of steel which has just been melted. To carry further the evidence as to the effect of an intense heat on iron in a vacuum is the task I have in prospect during my presidency of the institute. I may, however, express my agreement with Lockyer's view that the evidence afforded by the atmosphere of the stars shows that our terrestrial iron is a very complex form of matter.

We must not lose sight of those relations of carbon and iron which involve physical equilibrium. Even the astonishing associations of iron and carbonic oxide in the volatile gaseous compound with which the distinguished name of Mond is connected affords a triumph of dynamic chemistry. It is generally supposed that ozone is dissociated at 160° C., but Dewar has devised a beautiful experiment to prove that ozone has two centers of stability, and one of these is near the melting point of platinum. It seems to be the same with the relation of hydrogen and iron. We

FIG. 1.—BRAZILIAN DRAGON FLY FROM THE NEIGHBORHOOD OF RIO DE JANEIRO.
(Two-thirds natural size.)

have recently learned that iron and hydrogen appear to be completely dissociated at 800° C., and yet the same iron heated to some higher temperature, say 1200° C., will still yield hydrogen.

Let us suppose that Black, Cort, and Bergman were with us again and had reviewed the present state of our knowledge and the work accomplished in the century. Let us also suppose that they could go to Sheffield and see an armor plate rolled and finished for service, and then, visiting our institute, hear the best explanation we could offer of all the incidental phenomena they had witnessed. Which would they consider the more advanced, our practice or our theory? They would probably hesitate to tell us, but would offer warm congratulations on the immediate prospect of the establishment of a National Physical Laboratory, in which investigations as to the properties of iron and steel will be continued.

GIGANTIC INSECTS.

THERE is good reason for calling Europe a "temperate continent," not on account of the climate alone, but because there is symmetry, harmony, everywhere. The mountains are not too high to climb; the rivers are not too rapid and wild to be navigated, but flow peacefully through a succession of meadows, groves, and forests; from the tree tops we hear delightful, restful songs, instead of the disagreeable screams of tropical birds; While in the pastures there is a flutter of butterflies whose colors are most agreeable to the eye, though not imposing.

It has not always been thus; there was a time when the continent of Europe was covered with mighty forests that offered protection to mastodons, aurochs, and elands, whose heavy tread broke paths through the forests; and where the Rhine now flows between vine-covered hills there was a rushing, whirling torrent from which the dinotherium and other monsters raised their heads.

The gigantic forms of early times have disappeared from Europe; their hour struck when the tempestuous atmosphere became quiet and the changes of season became regular. The ice period was the last disturbing epoch, and after that the struggle for existence raged as in a battle; hundreds resisted the elements, and as the glaciers melted and winter withdrew to the north, Europe presented a different picture. Many of the enormous animals had disappeared, but those that still lived had, in the course of generations, adapted themselves to the winter and followed the ice northward. The last representatives of these perishing races fled to far-away Lapland and to the Lithuanian forests, where could still be found remnants of that primeval forest which originally covered everything. There the aurochs and the eland remained until the time came for them, too, to vanish forever.

In Europe new and elegantly formed creatures took the place of these Titans of the animal kingdom. We now have the delicate step of the deer in the forest where formerly the heavy tread of the great-horned megaceros was heard, and wise-looking lizards play on the banks where formerly the saurians bathed their mighty bodies; but in other parts of the world these radical changes have not yet taken place; hippopotami, elephants, buffaloes, and crocodiles still occupy extensive tracts in certain regions. In the tropics, among the creatures of the lower orders, we also find many forms that seem too large to belong to the present time. It sounds like a fairy tale when we hear of the butterflies of Brazil driving the delicate humming birds from the flowers so that they may gather the honey themselves; of lizards fleeing from gigantic wasps, and of little birds fluttering together in fright when a bush is invaded by a colossal locust, such as is shown, in natural size, in one of the accompanying engravings. Even the naturalist, perhaps the only person under the sun to whom these little monsters are a pleasing sight, needs to use great care in handling them. The giant locust has sufficient strength to force all the forty-eight tooth-like projections on his hind legs into the flesh of his captive until the blood flows, causing the unwary investigator much trouble. It is fortunate that these creatures are seldom seen, for if they should fly over the country in swarms, as our traveling locusts do, not a single leaf of even the luxuriant growth of the tropics would be left. Their home is along the banks of the great rivers of Northern Brazil, where the impenetrable forests lie a little back from the river, leaving a stretch of sand or turf, and where they rise with a great noise of their wings from the feet of the astonished travelers.

FIG. 2.—INDIAN WATER BUG.
(One-half natural size.)

The water bug, shown with spread wings in our engraving, is a native of East India, and, as it lives in the water, causes man very little trouble, except when, attracted by the light, he appears as an uninvited guest at the evening meal. On such occasions the food is generally left to cool on the table while he swims quite comfortably about in the soup plates. This insect also must be carefully handled, for the bent spine on his breast is as strong as a pencil point, and a wound inflicted by it is often very troublesome. These belostroma, like the locusts mentioned above, are not specially numerous, but one of their near relatives in South America is more obtrusive. In one evening hundreds of these water bugs are attracted by a lamp.

On the other hand, the great blue-green dragon fly that flutters about the wood streams of South America is quite harmless. It balances itself with wonderful ease, in spite of the fact that its body is 5·5 inches long. The reason for this prolongation seems to be to enable the creature to deposit its eggs far under water on the stems of aquatic plants without entangling its delicate wings. The water level of the forest pools is subject to such variation that even in shaded and protected places the young brood would often be left dry if the mother were not able to reach nearly to the bottom of the pool.

FIG. 3.—LOCUST FROM MOUNT HELICON, PROVINCE OF BAHIA, BRAZIL.

But such Goliah-like forms are better known in other species. In tropical forests one often sees butterflies of monstrous size flying above the tree tops as the birds do here. Six fore-wings of our largest butterfly—the Acherontia atropos (death's head moth)—would not be enough to cover a single wing of the Indian attacus atlas. In spite of their enormous size, these creatures are not at all conspicuous, because their form and color are such as to protect them.

The largest butterfly known, the Agrippina, measures more than a quarter of a yard from the tip of one wing to the tip of the other, but its color so nearly resembles that of the bark that it is difficult to find. The "ghosts," as they are universally called in the tropics, are so like twigs and leaves that one does not notice them unless they move.—Dr. Seitz, in Illustrirte Zeitung.

THE CHEMISTRY OF SAUSAGES.

THE composition of the sausage is not only complex, but it is often obscure. In this country (England) the preparation of this (as it should be) useful article of food is confined to the employment of minced beef and pork. The only exception probably is the so-called "black pudding," which is made with pig's blood and perhaps some heart and kidney. Abroad, however, the sausage is compounded of a much wider range of substances. These include brains, liver, and horseflesh. The last substance is generally considered repugnant, while, of course, it is fraudulent to sell sausages as beef or pork containing horseflesh. Occasionally, however, sausages do not contain meat at all, but only bread tinged with red oxide of iron and mixed with a varying proportion of fat. The remarkable feature of horseflesh is the high proportion of glycogen which it contains, and this fact enables the presence of horseflesh to be detected with some amount of certainty. The test, which depends on a color reaction with iodine, has recently been more carefully studied and with more satisfactory results, so that the presence of 5 per cent. of horseflesh in sausages can be detected. At present there is no legal provision for a standard in regard to the composition of sausages, but clearly there ought to be. Limitations should be laid down as to the amount of bread used, as to the actual proportion of meat substances present, and as to the coloring matters added to give an attractive appearance of fresh meat. Sausages are extremely liable to undergo decomposition and become poisonous, owing to the elaboration of toxic substances during the putrefactive process. Bad or rancid fat is very liable to alter the character of a sausage for the worse. Thus in some instances the use of bad or rancid lard has rendered the sausage after a time quite phosphorescent, an appearance which indicates, of course, an undesirable change. The smoked sausage is a much safer article of diet than the unsmoked sausage, since the curing process preserves the meat substances against decomposition by reason of the empyreumatic bodies present in the wood smoke which is used for this purpose.—Lancet.

THE SALT IN SALT LAKE.

A CONTRIBUTOR with a mind for statistics, writing for an unnamed exchange of The Pharmaceutical Era, quoted by that paper in its issue for April 13, figures out the following interesting facts about the Great Salt Lake. He says:

"It (the lake) is now about 100 miles long, with an average width of from 25 to 30 miles. It is from 50 to 60 miles wide in some places, and its greatest depth is about 60 feet. Its waters contain about 18 per cent. of solid matter, mostly salt and soda, with small proportions of sulfur, lithia, and boracic acid. The Asiatic Dead Sea water contains 23 per cent. of solids, including less salt and soda and much more magnesia, calcium, and potassium than Salt Lake. Atlantic Ocean water holds but 3·5 per cent. of solid material, of which salt constitutes 2·6 per cent. Hundreds of thousands of tons of salt are made by natural evaporation along the shores of the lake, and at one place near Salt Lake City a windy night never fails to pile up many tons of soda, eliminated by the movement of the waves.

"Compared with this vast liquid treasure house of riches, the greatest bonanza mines of Utah or of the United States dwindle to beggars' penny boxes. Take out your pencil and do a little figuring. Figures, it is said, will not lie, and you will soon find yourself dumfounded before your own mathematical truths.

"Say Salt Lake is 100 miles long and has an average width of 27 miles; that gives an area of 2,700 square miles. There are 27,878,400 square feet in a mile; so the lake has an area of 75,271,680,000 square feet. Take 20 feet as the average depth; then twenty times 75,271,680,000 will give us 1,505,433,900,000 cubic feet as the contents of the lake. Now 16¼ per cent. or one-sixth of this, according to the analysis of eminent chemists, is salt and sulfate of soda.

"That is, the lake contains 250,905,600,000 cubic feet of salt and sulfate of soda. Of this mass, one-eighth is sulfate of soda and seven-eighths common salt. A cubic foot of sulfate of soda weighs fifty pounds, and a cubic foot of common salt eighty pounds; so we have as the contents, in part, of this unparalleled reservoir of wealth 1,568,160,000,000 pounds or 784,080,000 tons of sulfate of soda, and 17,360,339,200,000 pounds, or 8,789,169,600 tons of salt. Allow ten tons to a carload, that would be 78,408,000 cars of soda and 878,016,960 cars of salt. Taking thirty feet as the total length of a freight car and its couplings, we would have a train of 445,500 miles long, or nearly to the moon and back, and a train of salt 4,988,730 miles in length, or long enough to reach 196 times around the earth and leave an 8,000-mile string of cars over on a side track. Running twenty miles an hour and never stopping, night or day, it would take the salt-laden train twenty-eight years, five months, and twenty-three days to pass a station."

HISTORY OF WEATHER TELEGRAPHY.

MR. WILLIAM FOSTER, JR., of Warwick, R. I., sends to the editor of The Monthly Weather Review some interesting notes about the early agitation of the question of a government weather bureau. He says that—

"In 1837-39 I published The Windham County Gazette, at Brooklyn, Conn., and occasionally had a paragraph on the subject of the weather, advocating a systematic series of observations to develop the law of storms. I removed to Providence in 1856, where I also had something to say on this subject in the press, insisting that the government should extend its weather work as widely as possible. Subsequently I reported auroras, meteors, etc., to Prof. Joseph Henry. I recollect that in one of my early paragraphs I instanced a severe damaging West Indian storm, which had traveled up the coast, as an example to illustrate the beneficent results that would have been attained if its progress had been noted and transmitted northward."

When necessary to cut gaskets from sheet packing, the work is rendered much easier if the knife is dipped frequently into a cup of water.

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